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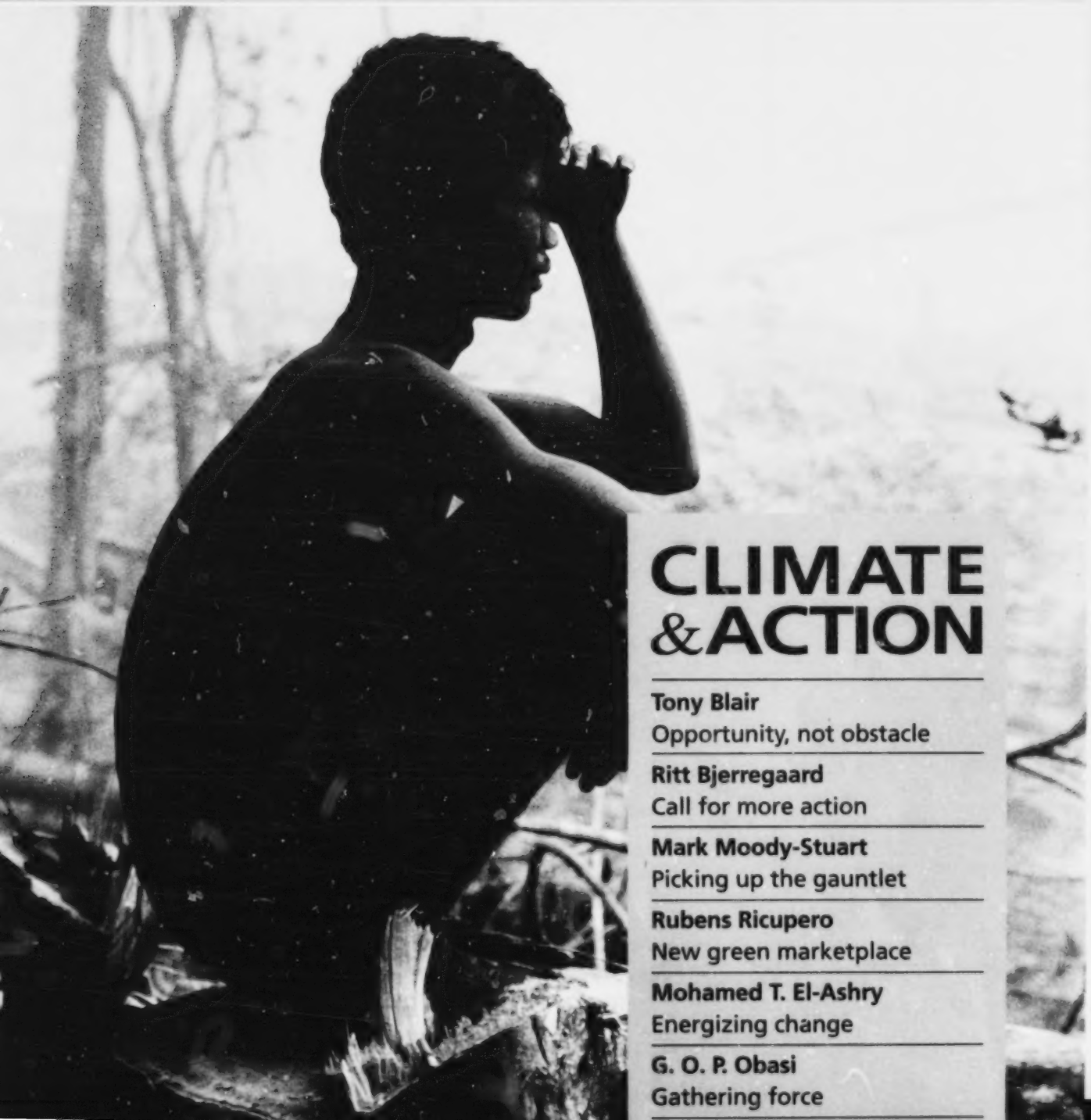

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THE LOST CAMELS OF TARTARY (Little Brown, £18.99) describes four expeditions – three sponsored by UNEP – that John Hare made to the Gobi desert in search of the wild Bactrian camel, one of the world's rarest animals. As a result of these, he is currently raising funds to establish the Lop Nur Nature Sanctuary and working on an environmental awareness-raising campaign for China.

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EDITORIAL

KLAUS TÖPFER
United Nations Under-Secretary General and Executive Director, UNEP

The Fourth Conference of the Parties to the United Nations Framework Convention on Climate Change will be different from the Third. More than a year ago, intensive deliberations resulted in the Kyoto Protocol.

Sober reflection on what was forged at Kyoto reveals a sense of optimism that, despite inadequacies, there is a solid platform upon which effective carbon emission control can be built.

Some feel that the Kyoto Protocol lost sight of the ultimate objective of the parent Convention on Climate Change, that is to stabilize atmospheric concentrations of greenhouse gases. Nevertheless, it has sent an important signal to investors and industries about the need and opportunities to introduce technologies that reduce carbon emissions. The Protocol contains the seeds for new markets in emissions that will, in the coming decades, take their place alongside traditional markets in commodities and financial instruments. The Kyoto Protocol could also be a turning point in making an orderly transition to an economy powered by renewable energy sources and production of more fuel-efficient vehicles.

Buenos Aires should be a 'nuts-and-bolts' meeting anchored in common sense whereby Kyoto's theory can be transformed into reality. All the basic elements are there – sequestration and sinks, joint implementation and emissions trading and the revolutionary Clean Development Mechanism.

It will be up to the delegates at Buenos Aires to give substance to these elements. There is widespread agreement that the Clean Development Mechanism provides ample opportunities for early and substantial emission reductions which can involve all parties, irrespective of their regional or economic affiliations, in collaborative, cost-effective emission reduction and climate control. The importance of the Mechanism should also be seen in its value as a bridge – with incentives – between developed, industrialized countries and the developing world.

UNEP's contribution

In collaboration with a number of relevant organizations, (the Convention on Climate Change, the Intergovernmental Panel on Climate Change (IPCC), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Development Programme, the United Nations Industrial Development Organization and the World Bank, amongst others) UNEP wants to contribute to the development of these international instruments, just as it did in establishing the IPCC with the World Meteorological Organization. UNEP intends to move beyond the information and science-based approach to define practical instruments, in particular economic instruments, to move forward to the implementation of the Kyoto Protocol and to lay the basis for its future strengthening.

In this regard UNEP and UNCTAD have jointly launched an initiative for an International Forum on Economic Instruments for Environmental Policy. The Forum will create a consultative process which is intended to contribute to efforts leading to the use of economic instruments for sound environmental policy. The process will also allow the consolidation of analytical work and experience to assess, compare and build coherence in the use of different economic instruments as part of a package of measures to achieve internationally agreed approaches. The process will involve close collaboration with relevant organizations, including those mentioned above.

Common sense tells us that it will require a concerted effort of both developed and developing countries, acting together, before we can guarantee stabilizing climate at a level that will prevent adverse effects – an objective adopted by all Parties and to be achieved with due account of historical obligations and differentiated responsibilities.

People's action

However, in the search for partners, we must not neglect domestic opportunities. While governments ponder, people are acting. There is no scientific conundrum more familiar to people than climate change. There is a groundswell of opinion requiring corrective action. Municipalities are applying energy saving schemes and adopting transport policies that provide documented emission savings and air quality improvements beyond the most optimistic targets of their national governments. They are doing so at little monetary cost and often have savings which further enhance municipal development. Awareness at the family level and application of simple solutions result in savings in domestic fuel bills. Enlightened utilities and small businesses are replacing energy costs with profits. Associations of business and service industries have climate awareness high on their agenda. Some, like the insurance and travel industries, are working with UNEP on codes of conduct that demonstrate environmental responsibility that others should envy.

Kyoto was looked to as an opportunity to make amends for the inaction in the post-Rio period. We must now look to Buenos Aires for the practical steps which will make effective emission control a reality•

OPPORTUNITY, *not* OBSTACLE

TONY BLAIR says that reducing emissions of greenhouse gases can increase competitiveness, employment and quality of life

Climate change is one of the great challenges facing our world. I do not, for *Our Planet*, need to run through the possible impact on our environment, and all who share it, if even the more cautious estimates of global warming and its consequences prove correct.

No one knows for certain how big the impact of climate change will be and how quickly it will happen. But the best evidence we have is that human activities *are* having a discernible impact on our climate. There is an uncertain future for us all unless we halt the rise in greenhouse gases being pumped into our atmosphere.

The choice before us is to act now to try to negate the effects or leave our children and their children to face the consequences of our inaction. I am delighted to say there is internationally a growing acceptance of the need to act.

I believe the agreement at Kyoto was a historic turning-point in tackling climate change. For the first time developed countries agreed to legally binding targets for reducing their greenhouse gas emissions. Overall emissions will be cut by more than 5 per cent below 1990 levels. The European commitment has been shown in our target to reduce emissions by 8 per cent, a target now being shared out between Member States.

At the special session of the United Nations General Assembly on the environment last year, I stressed the importance of getting agreement at Kyoto for all countries in the world. I pointed out that none of us would be able to opt out of global warming. I warned that failure at Kyoto meant failing our children because the consequences will be felt in their lifetime. I am proud of the role that John Prescott, the United Kingdom Deputy Prime Minister, played in helping forge that agreement.

All change

So far, so good. But I also warned in New York that we must deliver on the commitments we made. The real task and achievement will be for each country to meet its share of the reductions. It is important to realize that Kyoto is only the first step, vital as it was, and further progress will not be easy. It will require all of us – government, consumers and business – to change our ways of living and doing if we are to achieve this target.

But I want to strike a more positive note here. I believe too much of the debate on climate change has centred on the cost or 'pain' of reducing emissions. Virtue does not just have to be its own reward. I believe we should focus more on measures that reduce greenhouse gases but also improve our quality of life and the competitiveness and success of our firms. Let me give some obvious examples. Better insulated homes mean warmer homes, cheaper bills and lots of jobs. Improving energy efficiency leads to reduced costs for business. In the United Kingdom, we are working towards an integrated transport system, to offer attractive alternatives to some of the car use for some of the journeys we have to make in our daily lives. We believe this could make our towns and cities less noisy and less polluted.

I would strongly argue that tackling climate change should be approached not as an obstacle but as an opportunity. I understand why, for instance, there is some concern that the demand for reductions in emissions might be damaging for business and economic development. But I believe there is no contradiction between continuing to generate wealth while halting and reversing the side effects of those developments which are contributors to climate change.

This is important. As I have said, we all have our part to play in combating climate change. Just as all countries have a role to play in reducing global emissions, so all sectors within society must contribute to meeting national targets. In the United Kingdom, we have initiated programmes aimed at 'Greening Government' and encouraging the public to think environmentally. We will do more.

But the active support of the business community is vital. Without it, reducing emissions will be an uphill struggle. The facts speak for themselves. In producing the goods and services we want and transporting them to where we want them, business in the United Kingdom accounts for almost half the total national carbon dioxide (CO_2) emissions.

We have been fortunate in the United Kingdom. I am pleased to say the business community has shown itself largely to accept the need for action on climate change and has endorsed the role played by its Government in seeking agreement on the Kyoto Protocol.

The Advisory Committee of Business and the Environment (ACBE), consisting of highly respected board-level businessmen from top companies under the chairmanship of David Davies, has recently produced a study into the ways in which business can successfully contribute to meeting this challenge. The report concludes that if business responds to the climate change challenge now and in the right

manner, it will be able to manage and control the process in a cost-effective way, put in place long-term solutions and maximize the gains in terms of new markets and increased competitiveness.

ACBE, in its report, put forward a number of interesting and useful recommendations to both government and business. They are all based on the need to retain business competitiveness while reducing emissions. The Committee considered a range of policies and approaches designed to encourage all areas and sizes of business to respond to the climate change challenge while retaining the valuable business tool of flexibility.

The report looked at reducing reliance on carbon-based energy and the issue of achieving a behavioural change in the way energy usage is approached in business, and called for a stronger business focus on energy efficiency and carbon saving, urging all companies to consider their actions in the light of this challenge. Importantly, ACBE has recognized that increased efficiency and reduced waste can bring substantial cost benefits for the individual company, as well as contributing to national targets for reducing emissions.

To encourage more companies to take advantage of the savings which are available through energy efficiency, the United Kingdom Government is running a programme which provides information on energy efficiency best practice to both large and small companies. The results of this programme for individual companies can be significant. For example, a snack food company saved $1,536,000 and reduced CO_2 emissions by 12,000 tonnes in the first year after introducing a series of initiatives to reduce waste. Another company, a brewery, is making annual energy savings of $166,400, rising to $240,000 as a result of a more efficient refrigeration plant brought in to eliminate chlorofluorocarbons (CFCs). In reaching their business decision to invest in new equipment they recognized that this was a good opportunity to reduce energy costs.

To ignore these opportunities would be to rob our children's future through our own shortsightedness

ACBE's report also highlights the important role played by technology in meeting the challenge of climate change. It recommends that business should not only endeavour to apply and exploit those greenhouse gas reduction technologies currently available, but should carry out research and development on projects with potential for the middle and long term. I support their recognition of the contribution of technology to our climate strategy. The United Kingdom Government is already promoting the increased use of environmental technology through another of its best practice programmes. It aims to stimulate energy savings of $512 million per annum by 2015. In looking to the future, ACBE has pointed to the United States Climate Change Initiative as one way in which government and business can work together in this area.

Of course, the motives behind the development of such technology are not altruistic. The environmental technology market is big business, and set to get bigger. It is estimated that the global environmental market is currently worth $280 billion. By the year 2000 this is set to increase to $335 billion, and to $640 billion by 2010. Whilst it is all too easy to rely on old tried and tested methods, we need to look to the future. Forward-looking companies will recognize this valuable niche in the market and work to exploit it.

There are concerns that the push to improve environmental performance in developed countries may draw business away to 'pollution havens' where the rules are less stringent, or that by pushing for international action to reduce emissions we may hinder the growth of developing countries. I agree that we must share responsibility for meeting the climate change challenge, but accept that we should not expect developing countries to curb their legitimate aspirations for economic growth, as well as the need to eradicate poverty. However, I believe that companies investing abroad can be seen as a positive force for change, encouraging the take-up of environmentally preferable technology. With global markets and many businesses working on a worldwide basis, we must work to ensure that the older, more damaging technology is made obsolete. The sharing of best practice must extend beyond borders. Improving environmental performance and reducing emissions and resource use make good business sense, bringing increased efficiency and savings, wherever a company is based.

Positive force

The issue of engaging developing countries in the process of reducing global emissions will be one of the major topics at the Fourth Conference of the Parties in Buenos Aires when ministers from around the world meet to continue the work begun at Kyoto. Another key area they will have to address will be establishing the rules and procedures for the flexible mechanisms in the Kyoto Protocol – international emissions trading, joint implementation and the Clean Development Mechanism. In their work on climate change, ACBE supported such initiatives and have argued for an integral role for business. They see that by allowing the market to seek out the lowest cost options for emissions abatement, the targets could be approached in the most cost-effective manner.

I share this business enthusiasm for flexible mechanisms; used properly they will help to reduce developed country costs of emissions reductions, with tangible benefits for developing countries. At Buenos Aires the United Kingdom, in partnership with our European Union colleagues, will seek to ensure that these mechanisms operate in an effective and efficient manner and that the benefits they provide will be real and quantifiable.

We must act with determination at Buenos Aires to enable the Kyoto Protocol to achieve its full potential. To be honest, we cannot afford to fail. To meet the continuing challenge of climate change we must address the issue as a positive force for development, be flexible in our thinking and in our approach to potential problems. I believe there are significant benefits to be achieved for our health, wealth and society, and that to ignore these opportunities would be to rob our children's future through our own short-sightedness•

The Rt. Hon. Tony Blair MP is Prime Minister of the United Kingdom of Great Britain and Northern Ireland.

Call for more *action*

RITT BJERREGAARD calls for determined action to tackle climate change and outlines what Europe is doing

As early as 1990, after the adoption of the First Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), the European Union (EU) committed itself to stabilize its carbon dioxide (CO_2) emissions at the 1990 level by the year 2000. This was seen as a first step and we are on track to reach that target. The decision was based on the precautionary principle and took account of scientific knowledge which indicated the severe risk of irreversible climate change.

Why were the Europeans ready for this first step? We had learned from the painful experience of acidification, dying forests, the pollution of our lakes, coastal zones and rivers. The effects of environmental pollution were visible and recognizable to people who saw that preventing damage was better than trying to rectify it. There was also increasing recognition that our consumption patterns could eventually affect our planet as a whole. So Europeans accepted that the North had to take the first step in reversing emission trends.

Time has passed since 1990 but there has not been enough action. While the United Nations Convention on Climate Change provides the framework on which a global climate protection regime can be built, industrialized countries failed to commit themselves in it to binding targets. Instead they simply promised to aim for stabilization by the year 2000. It seems that most will fail even to get close to that goal.

Meanwhile, in its Second Assessment Report, the IPCC reiterated its general findings of 1990 and concluded that the balance of evidence suggests that there is a discernible human influence on the global climate. For me this means that we are now beyond the stage of precautionary measures. Taking into consideration the inertia of global systems we are now faced with rectifying damage. This is why the EU and its Member States wanted to have strong, legally binding commitments by industrialized countries in the Kyoto Protocol which would start to reverse longer-term emission trends.

Based on analysis by the European Commission, the EU came to the conclusion that a 15 per cent reduction of greenhouse gas emissions was technically and economically feasible if other industrialized countries undertook comparable efforts. We believe that in order to achieve a sustainable reversal of emission trends, the emphasis needs to be on domestic action. Therefore we attached great importance to common and coordinated policies and measures throughout the industrialized world. In our view this would facilitate the achievement of the common task, would reduce distortions of competition and be an incentive for technological change.

Moving forward

Our industrialized partners would not agree to a target close to our proposal. But they agreed to legally binding commitments which in itself is a major achievement. Moreover, those commitments represent a big step forward even if some countries were less ambitious than others. That is why Europeans want to have the Kyoto Protocol signed, ratified and implemented as soon as possible.

The European Commission is determined to play its full part in helping Europe to put the necessary policies and measures in place. In June 1998 it adopted a Communication which sets out the framework for a strategy to achieve the commitments under the Kyoto Protocol. On the basis of more detailed information from the Member States, we will flesh out that strategy to identify environmentally effective and cost-effective options for the EU.

In addition to proposing legislation for EU measures, the Commission will ensure a coherent approach to the use of the three flexible mechanisms which have implications for our internal market. We will monitor pro-actively the progress of individual Member States in meeting their own targets and in contributing to the achievement of the EU target. We will propose corrective action where necessary.

Since 1990 we have put several proposals on the table which can contribute to combating climate change and I hope that now that the EU and all the Member States have signed the Kyoto Protocol, the Council and the Parliament will speed up action on those proposals that remain outstanding. I am delighted that at their June Summit in Cardiff, Europe's leaders recognized the need to do more to integrate the environmental dimension in other policies and highlighted climate change and the energy, transport and agriculture sectors as first priorities for action.

In the energy area, the Commission has called for a commitment to double the share of renewables in the EU's energy balance to 12 per cent by 2010 and for measures to give electricity from renewables fair access to the grid in a liberalized market. We have highlighted the scope for further energy efficiency measures in the building sector, and for higher product standards. We have also made proposals to promote the use of combined heat and power.

In the transport sector, the EU has recently come to an agreement with car manufacturers on more fuel-efficient passenger cars and has issued a Communication setting out a strategy for reducing CO_2 emissions from transport, which would at least halve their growth by 2008-2012. The Commission has also tabled specific proposals, for example to further open up the rail market since we believe it is vital to shift freight off the roads.

The Common Agricultural Policy (CAP) is a key policy of the EU. There are a number of possibilities for action under the CAP which are relevant to climate change, notably in the field of rural development such as appropriate afforestation measures and promoting renewable energy crops. Further priority measures include better storage and treatment of animal manure to reduce methane emissions, and decreasing the use of fertilizers to reduce nitrous oxide emissions.

In industry, most energy intensive sectors have already improved energy efficiency significantly and are conscious of the need to do more. Sectors such as aluminium, cement, steel, chemicals and motor vehicles are active in promoting technological improvements to reduce emissions. However, tackling the three so-called industrial gases requires analysis of the options and commitments by industry.

Cross-cutting initiatives

There are a number of cross-sectoral policies that are particularly appropriate for action at the EU level. I am very keen for the Council to adopt our proposal for restructuring the EU framework for the taxation of energy products, which enlarges the scope of the EU minimum rate system beyond mineral oils to cover all energy products. The EU directive on the landfill of waste aims to reduce the biodegradable component of municipal waste thereby reducing methane emissions.

A number of provisions of the Kyoto Protocol are rather sketchy and, in particular, the flexible mechanisms need further elaboration in order to become operational. Our aim is to ensure that the environmental objectives of the Convention and the Protocol are respected in an efficient and cost-effective manner. Emissions trading, joint implementation and the Clean Development Mechanism complement each other and should be developed in a consistent way. Moreover, in our view, progress should be made simultaneously on all three.

A lot of work relevant to joint implementation was carried out before Kyoto and we need to capitalize on that. There has been feverish activity over the last year to clarify issues related to emissions trading and I hope that we will make considerable further progress in Buenos Aires. We will only do so if all countries contribute to the debate. In Europe's view only those who are able to monitor emissions accurately should trade. Moreover, we need a strict compliance regime in order to make sure that the flexible mechanisms are employed in a way which is both economically and environmentally sound.

The Clean Development Mechanism is, in my view, the most difficult to design, yet it has not received the attention it requires. It has huge potential to contribute both to a limitation of longer-term global emission trends and to sustainable development by providing an incentive for the transfer and application of environmentally sound technology. But it also has the potential to weaken the commitments of industrialized countries to reverse their emission trends. Agreement on key principles for the Clean Development Mechanism, and a common understanding of additionality and project eligibility should be one of the main goals of the Fourth Conference of the Parties in Buenos Aires. This can only be achieved through an open and constructive dialogue amongst all partners.

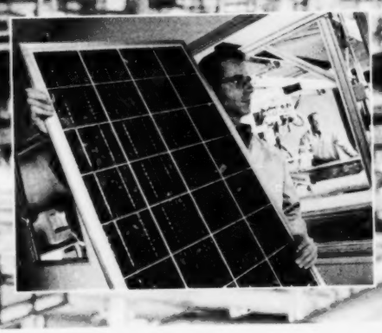
Agreement on key principles for the Clean Development Mechanism should be one of the main goals of the Conference

There is a lot on the Buenos Aires agenda and we must tackle it with skill and determination to give ourselves and our children a secure, sustainable future. They should not suffer the horrors of drought, forest fire and flood which we have seen over the last 12 months•

Ritt Bjerregaard is the European Commissioner responsible for the Environment and Nuclear Safety.

Brad Kelley/UNEP/Topham Picturepoint

PICKING UP THE GAUNTLET



Shell International Ltd

MARK MOODY-STUART describes how Shell is implementing the Kyoto Protocol and its commitment to developing renewable sources of energy

Companies can take the lead in practical action to combat climate change. The Third Conference of the Parties to the United Nations Framework Convention on Climate Change in Kyoto in December 1997 concentrated minds in the business world. Industry in general, the energy sector in particular – and we at Shell – must now play our part in helping the process to move from sensible words to effective deeds.

Industrialized countries made a legally binding commitment at Kyoto to reduce overall greenhouse gas emissions by an average of around 5 per cent compared to 1990 levels, over the first commitment period from 2008 to 2012. The aim of the Convention on Climate Change is to stabilize greenhouse gas concentrations in the atmosphere at a level which would limit the impact on the Earth's climate. But this needs to be done in a manner, and over a timescale, that will allow ecosystems to adapt while encouraging sustainable economic development.

We at Shell believe that Kyoto drew attention to this issue as never before – though the issues are undoubtedly complex and the detail may not engage the wider public. But if governments are seen to be more prepared to commit to controlling greenhouse gas emissions, people expect action to match that commitment. We think that economic development can only be sustainable in the long term if it balances growth alongside environmental risk. The key challenge is to explain how we propose to achieve that balance. Such explanation is necessary. As we said in *The Shell Report, Profits and Principles 1998*, published earlier this year, a sophisticated population looking towards the 21st century demands a 'show me' approach, having grown sceptical of the 'trust me' version offered by institutions in the past.

We believe that Shell's withdrawal from the much-criticized Global Climate Coalition in April this year is indicative of our commitment to this aim. It had become clear that our views and those of the Coalition were too divergent to warrant continued mutual involvement. The focus of the disagreement was the Coalition's active campaign against both ratification of the Kyoto Protocol by the United States Government and its opposition to targets and timetables generally accepted by Parties to the Protocol.

Consistent approach

Shell, like every other publicly owned company, must protect shareholders' investment and provide an acceptable return. It must continue to win and maintain customers but, of course, it has responsibilities to other stakeholders too. We must also ensure that our businesses are run in an ethically acceptable manner and in accordance with specific environmental responsibilities. We are proud of our formal Statement of business principles and our formal Commitment to the management of health, safety and the environment. These ensure a consistent approach in all of our Group of companies to these worldwide responsibilities.

According to the scientists of the Intergovernmental Panel on Climate Change, the balance of evidence suggests that there is a discernible human influence on global climate. In spite of the considerable scientific uncertainties which remain about the nature, process and impact of climate change, Shell believes there is sufficient evidence to support prudent precautionary action. Prudence does not mean delay but equally it does not mean precipitous action. Taking measures so hasty that they threaten the stability of the energy industry, and therefore its vital, current and ongoing contribution to the economic development of societies, could be as damaging as doing nothing. Practicality is the watchword.

Fossil fuels currently supply about 85 per cent of global primary energy needs, and the continued use of oil, gas and coal is inevitable for the foreseeable future. More reserves will have to be found to sustain population growth and improve living standards over the next few decades, particularly in developing countries. Although there are currently no generally available alternatives to fossil fuels at acceptable cost, we do expect renewable sources to become cheaper and more widely available during the next half century. Greenhouse gas emissions could peak in the period 2020-2030, leading to eventual stabilization of atmospheric carbon dioxide (CO_2) levels – close to the European Union target of double pre-industrial levels.

Looking ahead

Our vision for the future includes radical changes in energy supply and consumption. That is why we have decided to invest $500 million to establish renewables as a core area of Shell's business. We have created Shell International Renewables (SIR) – a separate business unit – and have given it the same status within our Group as our traditional oil and gas exploration and production business. SIR will devote most of its efforts to biomass power generation, solar electricity and forestry – while keeping an open mind on other renewable energy possibilities such as wind power. These sources of renewable energy could be providing between 5 and 10 per cent of the world's energy needs within 25 years, possibly expanding to 50 per cent in 2050. Make no mistake: Shell is committed to renewable energy as a business opportunity, not as a publicity exercise. We are preparing now to be able to take advantage of the very different energy market that will be in place in 50 years' time. It would have been a foolish carriage maker who did not, at the turn of the last century, embrace the internal combustion engine.

In the more immediate future, though, the Kyoto Protocol provides three flexible mechanisms for implementing the agreement reached last December, which should eventually be joined together through a system of linked credits:

- Emissions trading, which will create an international market in permits to emit CO_2-equivalent emissions.
- Joint implementation, through which projects to reduce emissions or enhance carbon sinks such as forests will be organized cooperatively amongst Annex I (industrialized) countries.
- The Clean Development Mechanism, which will assist developing economies (non-Annex I countries) to achieve ▶

emissions reduction and support sustainable development. It will also help Annex 1 economies to meet their quantified emission targets.

Shell is committed to renewable energy as a business opportunity, not as a publicity exercise

Together these mechanisms, soundly designed, should provide the least costly way of achieving the Kyoto targets. To make it work, business must be encouraged to play a full part and unnecessary bureaucracy must be avoided. If these conditions can be met, one of the keys to managing economic development and the risks of climate change may have been found. Let me deal with each mechanism in turn.

Emissions trading will operate by creating a new commodity – a permit to emit a unit of CO_2-equivalent emissions. A similar, successful system for trading sulphur oxide permits already exists in the United States, although an international carbon trading system will be much more complicated to implement. In order to make greenhouse gas trading equally successful a number of problems will need to be resolved.

How should these emission trading permits be allocated? Ideally, Annex 1 countries should be able to distribute a proportion of their permits to companies or citizens within the system. A precise mechanism for making permits and credits interchangeable between parties needs to be developed. Eventually, it should be possible to allow credit trading between all three flexible mechanisms. If the system is to win the confidence of companies, governments and the public, there must be effective procedures to regulate, monitor and enforce trading integrity and transparency.

If these specific requirements can be met, companies and countries that exceed their greenhouse gas reduction targets would be able to earn cash by selling permits to countries that find it more difficult to reach them. In this way, emissions trading could offer an efficient, market-driven method of reducing greenhouse gas emissions.

The aim of joint implementation is to help host countries meet their own commitments and create surplus allowances that can then be used as credits. Joint implementation aims to encourage Annex 1 countries, or companies authorized by them, to establish cooperative ventures in emission reduction and sink enhancement. Business has a role to play in helping to get these mechanisms off the ground, and the provision of early credits would be a powerful stimulus.

Provided sufficient attention is paid to its design, joint implementation could achieve several important goals:

- Technology transfer between participants.
- Capacity-building in countries with economies in transition, such as Russia and Ukraine.
- Provision of a pool of credits which will ultimately lower the cost of reducing emissions.

The private sector will propose and fund joint implementation projects if they are commercially viable. Low transaction costs, minimum project delays and the protection of confidential information will all be essential. The credit system needs to be based on actual emissions reduction and must allow individual businesses to negotiate project by project.

The Clean Development Mechanism is designed to help non-Annex 1 countries to reduce their greenhouse gas emissions and achieve their sustainable development objectives, as well as assisting Annex 1 countries to fulfil their commitments. Transactional costs and the time needed for approval must be minimized to ensure that such projects are economically viable.

Of course, ultimately, we must be able to prove that these measures make a difference. Critical to the success of both Clean Development Mechanism and joint implementation projects will be quantifying emission reduction over and above what might have occurred without such initiatives. Only then can we be sure that the flexible mechanisms are achieving their objectives. If these complex issues can be addressed, the transfer of technology will help to raise standards at the same time as enhancing our ability to meet targets for greenhouse gas reductions.

Dialogue and debate

If the momentum of Kyoto is to be maintained, governments will need to make progress at the Fourth Conference of the Parties in Buenos Aires in November.

Government and industry must keep talking. Only through dialogue can we ensure the appropriate dissemination of information and experience. Shell companies, like other multinationals, believe that their knowledge of energy markets, project execution, technology transfer and oil trading enables them to contribute to this debate and to discuss practical measures with governments in countries where they operate.

Shell companies will also play their part directly in making the energy savings needed to meet the Kyoto targets – and helping customers to play theirs. All Shell companies set themselves environmental targets. Total emissions of CO_2 from Shell operations are projected to fall by 26 per cent between 1997 and 2002. Emissions of volatile organic compounds and methane are projected to drop by 22 per cent. A major factor in these reductions is the target set by our Exploration and Production business to reduce flaring from 9 million tonnes of gas today to some 5 million by 2002, and to eliminate the disposal of gas through continuous flaring by 2008.*

Climate change is a long-term issue – far longer term than the first commitment period which ends in 2012. If a workable framework for the flexible instruments can be put in place in Buenos Aires then the conditions will have been created to address climate change over the long term. Shell has picked up the gauntlet of implementing Kyoto. Will governments?•

Mark Moody-Stuart is Chairman of the Committee of Managing Directors of the Royal Dutch/Shell Group of companies.

* *Further details of Shell companies' performance and objectives can be found in the* Royal Dutch/Shell Group Health, Safety & Environmental Report 1998 *available from Group External Affairs, Shell International, Shell Centre, London SE1 7NA, United Kingdom, or on www.shell.com*

The new green marketplace

RUBENS RICUPERO assesses the effects of market forces on the environment and the role of economic instruments in addressing global warming

New markets in greenhouse gases are likely to take their place alongside the traditional ones in commodities and financial instruments as a result of the Kyoto Protocol, a watershed in the history of multilateral environmental cooperation. The seeds of these markets are contained in the Protocol's provisions for trading 'assigned amounts', 'emissions reduction units', and 'certified emissions reductions'.

Vast new areas of business activity are likely to emerge, from investing in technological innovation to new roles for financial analysts, project developers, accountants, certifiers, brokers, insurers and data providers. The result would be a significant transformation of the way we live and trade, the way economies grow, and the relationship between those countries which are now rich and those which are now poor.

For most of the past 15 years, we have been living under the intellectual, political and practical hegemony of a current of thought and action that – starting with von Hayek, Popper, Coase and Friedman – rehabilitated the market as the central mechanism for achieving growth and balance in the economic sphere. After the collapse of the communist regimes in the early 1990s, a tremendous boost was given to the accelerated unification of the economic space worldwide with the final goal of establishing a single, unified, global market for production and trade. Ironically, the environmental movement has simultaneously been moving in the opposite direction.

For those committed to the defence of our planet's ecosystem, the market as a pricing mechanism is of little help as long as the current pattern of price formation does not adequately reflect environmental costs. This is why the environmental movement has relied much more on regulation and on the power of the state as arbiter – at the very moment when economies as a ▶

whole are actively promoting deregulation and the withdrawal, or containment, of the state in the fields of production and trade.

Markets and accounting systems often fail to recognize natural resources, such as air and water, as assets in the true sense of the term, or to value resource-based goods and services properly. Misleading information about scarcity values is the source of this failure. In turn, this creates a faulty decision-making process in relation to managing, utilizing and enhancing natural resources. Too many resources are allocated to activities that generate external costs, and too few to those that generate external benefits. If these resources are to contribute most effectively to sustainable development, their prices should reflect the full range of the costs involved in utilizing them – including the costs of the external effects associated with exploiting, transforming and using them – together with the cost of future uses forgone. Broadly speaking, these could be seen as forming a package of environmental costs, to which a notional price can then be attached.

Internalizing costs

Unfortunately, this desirable process rarely happens. Indeed, without government intervention, and in the absence of well-defined property rights for public goods or goods to which access is generally open – such as clean air, clean water or biological diversity – these environmental assets have been treated as free goods in the economic production process. Consequently they have been overused in production activities. There is a clear need, in these cases, for governments to intervene in order to create the conditions for internalizing the external costs associated with such overuse, especially where the sustainability of environmental services is endangered. The basic principles of internalization within an appropriate regulatory framework – which creates the necessary correct regulatory conditions for the pricing system to perform effectively what economists call its allocative function – are as valid in the case of climate change as with any other environmental problem.

Shaw's Arena/EXPO photo Picturepoint

The new incentive structures will bring both new challenges and new opportunities

The international emissions market is a good case in point. Some have argued that we cannot leave the climate problem to trading, and that serious governmental action is required. This ignores the fact that emissions trading is first and foremost part of a regulatory mechanism. Trading is possible only within a framework of legally binding numerical limits – established, supervised and enforced by governments. The market plays a complementary role – its allocative function – mobilizing private resources in pursuit of the public good.

Special consideration needs to be given to the position of developing countries in this process. They have contributed little to the build-up of greenhouse gases in the atmosphere and have not enjoyed the benefits of the economic growth that generated it. Most are still in the initial stages of their development process. They therefore cannot be denied their right to grow, nor should their development be constrained by the imposition of undue costs and hindrances.

Voluntary measures

If developing countries are to increase their per capita incomes beyond current intolerably low levels, they must continue their industrial growth. In doing so, they are likely soon to become significant sources of additional emissions, even while these remain at relatively low per capita levels. Many have already undertaken voluntary measures designed to limit the environmental impact of their needed growth. They have also indicated their willingness to cooperate in global efforts to reduce the risk of climate change, so long as their interests can be protected and their needs met on a fair and equitable basis.

While the Kyoto Protocol imposes no new commitments on developing countries, the prospect of trading certified emissions reduction under the Clean Development Mechanism opens up interesting possibilities. Voluntary participation by developing countries in emissions trading also needs to be given proper consideration. Indeed, effectively combining Clean Development Mechanism operations with the appropriate level of integration of developing countries into the wider emerging global emissions trading market is essential if the Mechanism is to realize its full potential. Without a vibrant and liquid international emissions market, in which the private sector is allowed to play its proper role, the Mechanism could well fail. While developed countries must take the first step in reducing emissions of greenhouse gases, developing ones must be careful to avoid being left out of the new emerging markets.

A new paradigm

The new incentive structures bearing on technological innovation and diffusion, investment, finance and trade will bring both new challenges and new opportunities. There is a clear need better to understand, articulate and promote the interest of developing countries 'in the new environmental markets paradigm'. With almost eight years of experience in emissions trading, the United Nations Conference on Trade and Development Secretariat is well placed to assist the international community to design and implement a sound and truly global emissions market•

Rubens Ricupero is Secretary-General of the United Nations Conference on Trade and Development.

Over the last two years more than 16,000 people have been killed worldwide by the weather and, according to one estimate, nearly $50 billion in damage has been done. Communities around the world have seen their lives disrupted, crops destroyed and homes swept away. Nine of the last 11 years were among the warmest recorded, 1997 was the hottest year ever, and each of the first seven months of 1998 was the warmest in 140 years.

The facts are clear. Many of the world's major media have reached a conclusion similar to that of the conservative *Chicago Tribune*: 'prudence and common sense – and mounting scientific evidence – tug at us ever more insistently, suggesting that warnings about global warming must be taken seriously' and that 'realistic plans' should be made.

ENERGIZING CHANGE

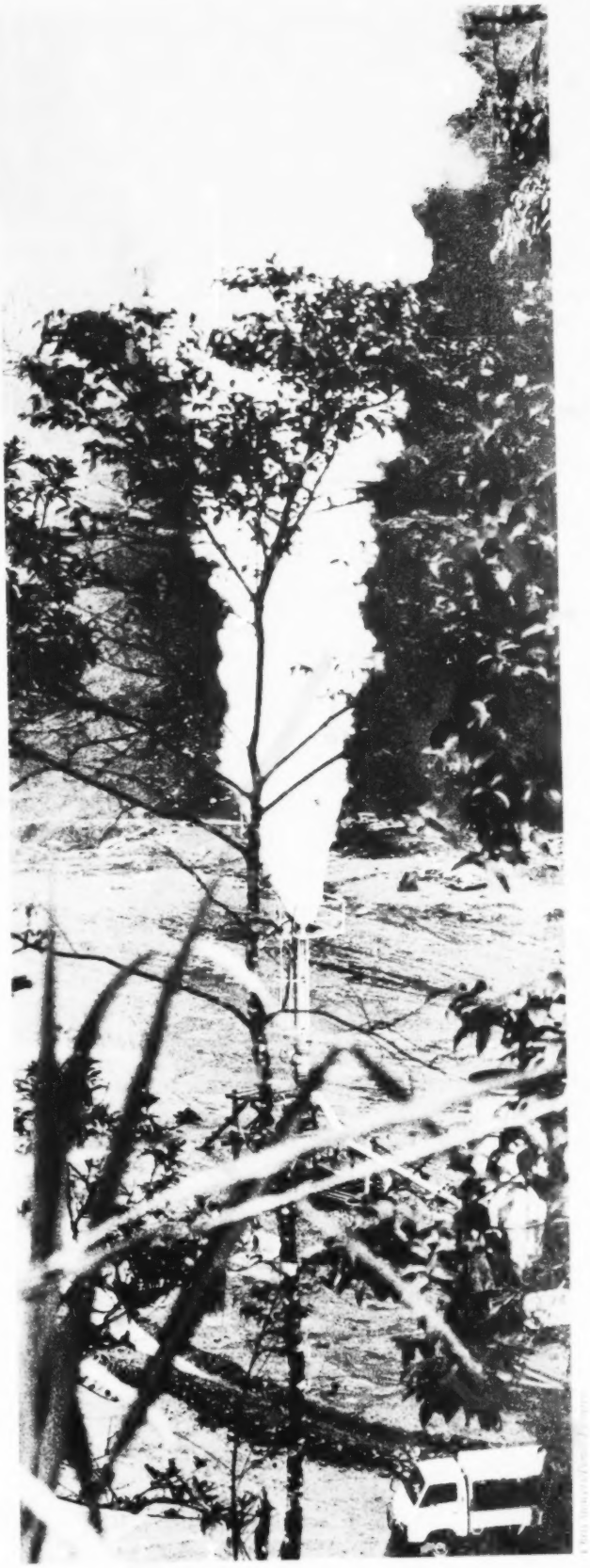
MOHAMED T. EL-ASHRY describes the GEF's work to combat climate change

Since its creation in 1991, the Global Environment Facility (GEF) has committed over $725 million to nearly 200 projects in 49 nations in concrete action to combat climate change. Its activities are implemented by UNEP, the United Nations Development Programme and the World Bank. Some examples from GEF's three operational programmes:

Removing barriers to energy efficiency and conservation. Cost-saving technologies are not readily adopted because of such barriers as high initial costs and lack of public awareness. A $5 million GEF programme has helped the private sector develop a market for energy-efficient light bulbs in Poland which has resulted in large power savings and reduced emissions from coal-fired generation plants. Here, as in other countries, the success of attempts to manage energy demand is strongly linked to effective awareness and information campaigns: non-governmental organizations play a key role. The GEF is also supporting energy efficiency programmes in Brazil, Bulgaria, Chile, China, Côte d'Ivoire, Egypt, Jamaica, Mexico, Russia, Senegal, Syrian Arab Republic, Thailand and other countries.

Promoting the adoption of renewable energy by removing barriers and reducing implementation costs. GEF has formed a partnership with the Philippine National Oil Company and the National Power Corporation to construct a geothermal plant instead of a coal-fired plant. GEF contributed $30 million to the $1.3 billion project to pay the incremental cost of transmitting electricity produced by the plant to the national grid.

More than 10 projects – including a $7 million initiative in Zimbabwe – are expanding the rural use of photovoltaics, assessing the technology and how it is promoted, and providing a model for other countries. Funds are used for ▶



market development, including training installers and creating standards and public awareness. Some projects – such as the Indonesia Solar Home Project, the largest in the world – include subsidies (usually declining to zero over several years) to build market volume and create initial demand. Long-term success, once GEF funding is completed, will depend on strong local responses.

Future generations will benefit from the Convention's leadership in recognizing a real and present danger

Reducing the long-term costs of low greenhouse gas-emitting energy technologies. GEF is working with the Brazilian Ministry of Science and Technology and private Brazilian companies to commercialize an environmentally friendly technology that generates electricity from wood chips from plantation forests. Its $40 million investment in the project has leveraged an additional $82 million from its partners. Like other projects involving fuel cell buses and solar thermal power plants, it supports a technology of particular promise to developing nations.

GEF also funds projects designed to have a demonstrable short-term and inexpensive impact on greenhouse gas emissions, even if they are not part of an operational programme. A $10 million GEF project in China has successfully demonstrated technologies that reduce methane emissions associated with coal mining and recover the gas for use as a fuel. Several exploration and development agreements for joint ventures have been signed with international investors as a result, and more are under active negotiation.

In every case the policy framework and enabling environment are extremely important if alternative energy and more energy-efficient products and technologies are to be successfully adopted and replicated. Thus engaging stakeholders – governments, communities, non-governmental organizations, the scientific community and the private sector – in designing projects is essential.

In Argentina – host to the Fourth Conference of the Parties to the United Nations Framework Convention on Climate Change – GEF is supporting a new $13.5 million component of a $2.2 billion World Bank project to promote renewable energy in rural markets. As part of a strategic rural electrification programme, it is substituting solar energy, wind power, and mini-hydro schemes for diesel generators, normally the cheapest alternative. The project will involve private investors and power developers – as well as Argentina's National Rural Electrification Laboratory – to supply power to over 130,000 rural households and about 4,400 public services, including schools and medical centres.

Much of the discussion at the Conference is expected to focus on emission trading and the Clean Development Mechanism envisioned in the Kyoto Protocol. Developing countries are looking to this Mechanism for the infusion of funds they need to finance alternative energy strategies for sustainable development; developed country expectations centre on opportunities to trade emission rights. Achieving an outcome acceptable to all will not be simple. But future generations will benefit from the Convention's leadership in recognizing a real and present danger and cooperating to safeguard the planet. As always, the GEF stands ready to play its part •

Mohamed T. El-Ashry is CEO and Chairman of the Global Environment Facility.

Small is *dutiful*

TERRY DONALD COE describes the action Niue is taking with the help of UNEP and the GEF

No matter how small a nation may be, it is contributing to global warming and should become part of international efforts to combat it. Niue – an island about 65 kilometres in circumference in the South Pacific, with a population of some 2,000 people – is committed 100 per cent to the global goal of participating in the protection of our climate.

The traditional belief on Niue was that climate was the creation of God and that any changes that occurred were His way of doing things. There used to be a strong local opinion that we should not disturb God's work but should leave well alone.

However, there was a noticeable change of view, especially in the middle-age group range, after a national climate change awareness workshop conducted on 10 March 1998. About 70 local participants and six international experts attended and great interest was generated. For the first time a large number of nationals became aware of the problems that could arise as a result of climate change.

Specific tasks

From that moment on, six groups were given specific tasks for the preparation of our first national communication. The groups consist entirely of local experts, with the provision to hire expatriate consultants should the need arise.

The Greenhouse Gas Inventory group is well on the way to completing its task. Its work has highlighted the need for proper documentation and coordination of data from all sectors, and for integrating it within a centralized planning unit. It has also shown that in the base year, 1994, Niue emitted a total of 4,931.003605 gigagrams of carbon dioxide by burning fossil fuels.

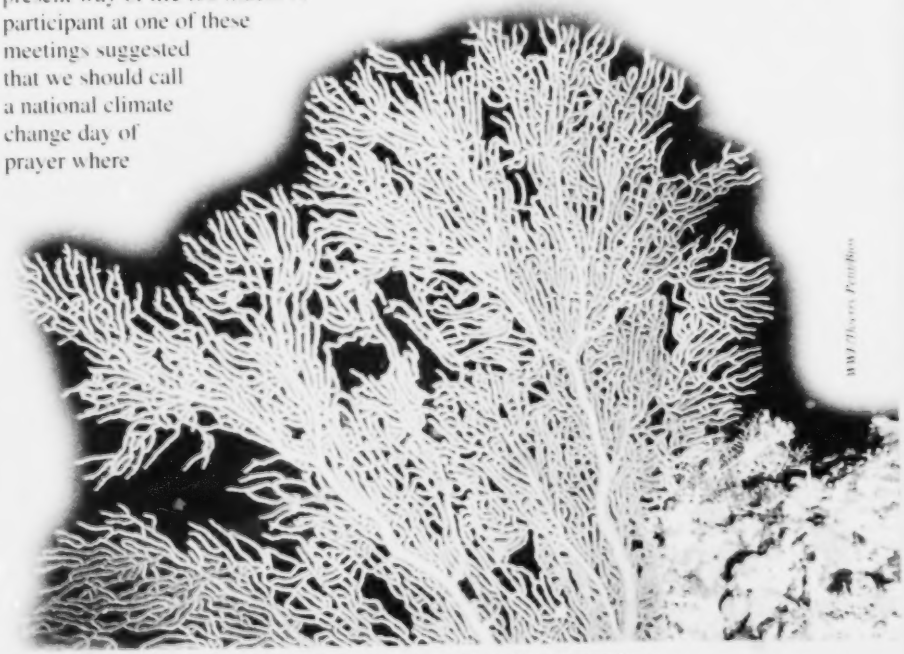
The Education, Training and Awareness group took a direct approach by conducting meetings with each village. The most striking response at these meetings was that the revelations about climate change and its possible impacts – especially on small island nations like ours – were very frightening. Almost 99 per cent of the people responded in favour of adopting better ways of using energy and concluded that policy makers should come up with realistic policies for this without compromising the present way of life too much. A participant at one of these meetings suggested that we should call a national climate change day of prayer where all nationals would congregate to give prayers to God to protect our Earth.

The awareness programme includes schools. The primary schools have already included climate change issues in their programme and staged a number of dramatic events, watched by parents and the general public, which showed impressive enthusiasm and understanding of climate change issues. One, where children wore sacks with greenhouse gases painted on them and spoke of how it is not good to produce too much of these gases, had a great impact on the audience.

A climate change talent quest held this summer, and attended by 200 to 300 people, was a great success. The message about protecting our climate was prominent in the composition of the songs. These will assist our awareness programme through the media, with radio broadcasts every fortnight and television clips on Sunday nights. Much of the general public on Niue is now very much aware of climate change and further efforts are being encouraged to maintain this high level of interest.

Mitigation strategies

The Government has already drawn up a National Environmental Strategic ▶



WWF Hayes Peter Bass

South Pacific coral reefs stand to suffer from the rise in sea temperature expected as a result of climate change.

Management Plan that highlights our vulnerability to severe weather conditions such as droughts, cyclones and tsunamis, and to sea-level rise and misuse of the land. Sea-level rise is of particular concern because it could severely affect our only source of fresh water, the underground water lens. Mitigating options would be very expensive for a small island nation such as ours, but the Mitigation and Options group is looking at approaches that are applicable to our situation. Adapting to new ways in order to cope with climatic changes may prove to be difficult for many of our people.

The Environmental group has found that our very thin, porous and infertile soil is vulnerable to prolonged dry spells. Our fragile ecosystem is also vulnerable to major climatic changes, which will definitely affect our way of life. Some of our basic traditional wild staple foods – on which we usually rely during long dry spells – are not as abundant as they were 20 years ago. This cannot be due to overharvesting because our population is decreasing. These obvious changes to our habitat were pointed out by elders at village meetings and are causing great concern amongst our people. They often ask whether they are a sign that the world is coming to an end and that the Messiah is coming.

The Capacity Building group has highlighted the need for our nation to build up our resources in terms of expert personnel. Very few of our people are academically trained, though they have built up local knowledge over the years. The Government has indicated that whatever this group proposes should be incorporated into the National Action Plan now being prepared. The Vulnerability and Impact Assessment and Adaptation group is also working hard to try and fulfil its specific tasks.

Global Environment Facility (GEF) funds, provided through UNEP, permitted us to start our climate change enabling activities in preparation for our first national communication. They are well under way and we hope to complete them in December next year.

Niue urges all countries to work together to reduce emissions to a more manageable level

Niue urges all countries – especially developed ones whose greenhouse gas emissions are huge – to work together to reduce emissions to a more manageable level in the near future. Public awareness is the key. The more people at all levels worldwide become aware of the problem, the easier it will be to convince them to start changing their habits and start protecting our climate. This will be especially so if they are made aware that the magnitude of problems that could occur as a result of our ignorance is of devastating proportions•

The Honorable Minister Terry Donald Coe is Minister in Charge of Telecoms, Meteorology, the Electrical Power Corporation, the Public Works Department, Administration and Agriculture, Forestry and Fisheries in the Government of Niue.

ENABLING ACTIVITIES

The First Conference of the Parties to the United Nations Framework Convention on Climate Change agreed to help developing countries build their national capacities to respond better to climate change. It also asked the GEF to provide funding for these efforts: measures such as planning and capacity-building, including institutional strengthening, training, research and education.

The GEF's Enabling Activity Programme is now four years old. About 200 projects are under way or have already been implemented by the GEF and its implementing agencies (UNEP, the United Nations Development Programme and the World Bank) and bilateral programmes. Most developing countries have been covered and more than $10 million has been committed.

Under the Convention on Climate Change, even developing countries have to submit a national inventory of sources and sinks of greenhouse gases, and of programmes to reduce the negative impacts of climate change. This has to be submitted within three years of the date the Convention enters into force in that country, or of the time financial resources are made available from the GEF (least developed countries are exempted from this time limit).

These 'national communications' must include descriptions of programmes to address climate change and its adverse impacts, measures for abatement and enhancing sinks for greenhouse gases, policy options for monitoring systems and for strategies for responding to the impact of climate change, and policy frameworks for implementing adaptation measures and response strategies.

UNEP has been active in this area since before the Convention was signed in June 1992. It undertook the very first GEF project in enabling activities in 1991, now completed but involving Costa Rica, the Gambia, Mexico, Morocco, Poland, Senegal, Venezuela, Uganda and the United Republic of Tanzania with a grant of $4.5 million. In 1994, two more UNEP projects on enabling activities received GEF funding: a $2 million project involving Antigua and Barbuda, Cameroon, Estonia and Pakistan, also complete; and a $3 million project involving Argentina, Ecuador, Estonia, Hungary, Indonesia, Mauritius, Senegal and Viet Nam, which is currently being implemented.

Since May 1996, UNEP has helped a number of developing countries access GEF funds for preparing their initial national communications. Fifteen project proposals had been approved in Africa, Asia and the Caribbean region by 15 August 1998 and UNEP is helping another nine countries prepare project proposals.

Niue is one of the projects funded by the GEF and assisted by UNEP.

Ravi Sharma, Task Manager, GEF Climate Change Enabling Activities, UNEP.

Tax bads, *not* goods

ERNST ULRICH VON WEIZSÄCKER and **HERMANN E. OTT** say that an ecological tax reform is the most effective way to meet the targets for reducing emissions of greenhouse gases

Ecological Tax Reform presents an opportunity to achieve the targets set out in the Kyoto Protocol. These legally binding reduction targets for all major greenhouse gases, a major step forward in international efforts to avert the threat of climate change, provide appropriate pressure on governments to act. But they must also be implemented.

Before Kyoto, the European Union (EU) devoted considerable time and energy to incorporating policies and measures into the Protocol. Its proposal contained a list that would either have to be implemented as common measures or be compulsory for all Parties. This was not acceptable to many other countries and unfortunately distracted from the substance of the issue. But the Protocol, in its final form, does enumerate a range of suitable instruments for implementing commitments that would benefit from international cooperation. And the EU was able to apply enough pressure for the Parties to agree on a process that can facilitate cooperation and coordination in years to come.

One of the instruments listed in Article 2 of the Protocol concerns reducing or phasing out market imperfections and incentives that run counter to the objective of the Convention. Parties are also requested to 'apply market instruments'. This, combined with other policies and measures in the article, recognizes the prime role played by energy and resource prices in the fight against climate change. Yet subsidy policies in almost all industrialized countries now favour precisely those fuels that have a high carbon content. Reversing this trend through Ecological Tax Reform is recognized throughout the world as one of the main pillars of climate policy. As the World Resources Institute has recently pointed out, developing countries actually seem to be ahead of developed ones in reducing these ecologically and economically perverse subsidies.

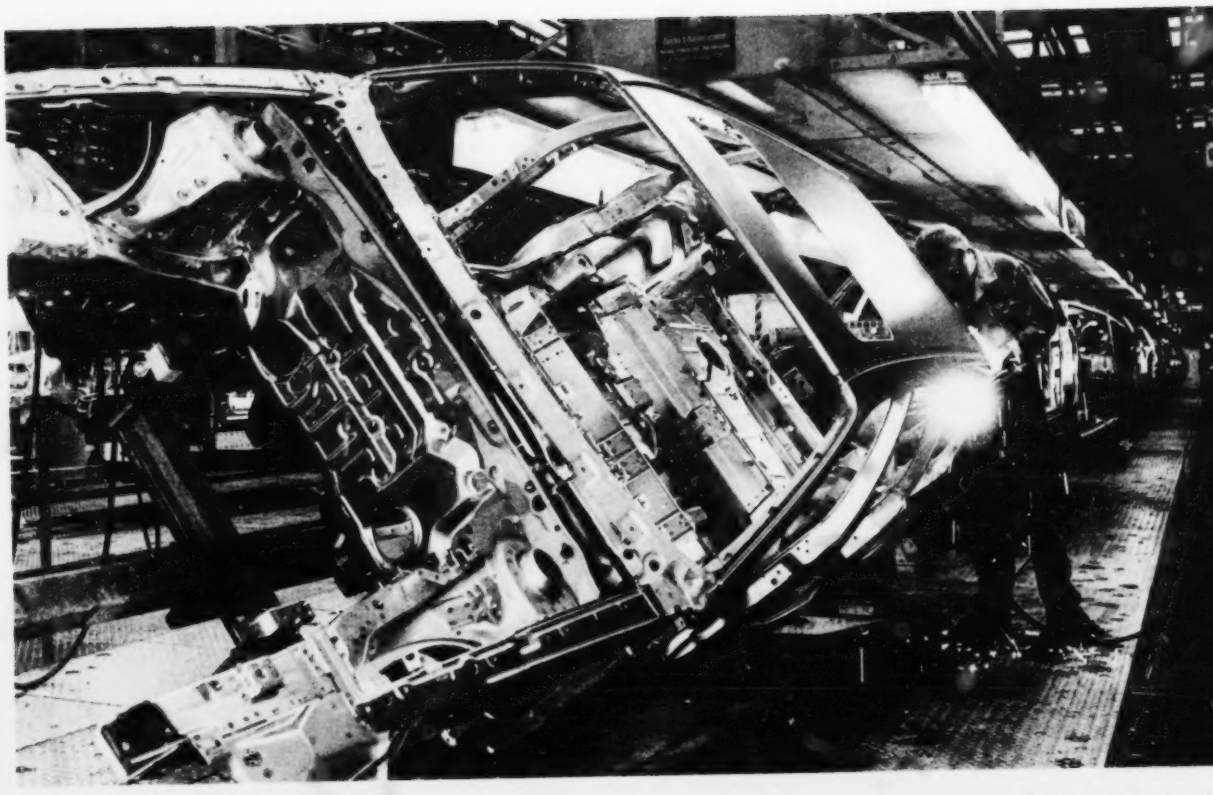
Removing subsidies, however, is only one side of the coin. It has rightly become commonplace in the climate and environment debate that 'prices should speak the ecological truth'. Many studies show a positive correlation between the rising energy prices of the 1970s (caused by the oil price crisis), the innovative forces of the market and the economic performance of countries. Rising prices for energy and resource use do not only have a direct impact on consumption, but spur technological development for the revolution in efficiency that is so badly needed.

Great expectations

How are we going to live in a world with as many as 10 billion people demanding a lifestyle comparable to the unsustainable one enjoyed by most inhabitants of industrialized countries today? Even if developing countries only doubled their emissions of greenhouse gases by the middle of next century, the developed ones would have to reduce theirs by a staggering 80 per cent in order to avert dangerous interference with the climate system.

If all the citizens of the Earth are to be provided with a comparable standard of living without endangering the livelihood of future generations, there has to be a switch to renewable energy sources and changes in lifestyle, and at least a fourfold increase in resource productivity. Ecological Tax Reform has been widely acclaimed as the least bureaucratic, the least intrusive and probably the most powerful instrument to achieve this.

Taxing 'bads' like energy and resource use – and not such 'goods' as human labour – has been shown to yield immense ecological and economic benefits. This is why the Scandinavian countries, the United Kingdom and The Netherlands have already successfully introduced 'green' elements into their tax systems. France will soon follow. In 1997 Slovenia was the first country from Central and Eastern Europe to introduce a carbon dioxide (CO_2) tax: it tripled its rate in 1998. The EU ▸



will have to rely on pricing policies to implement its 8 per cent emissions reduction target. In fact, when the EU agreed how to share out this burden this summer, The Netherlands expressed a strong conviction that the targets demand a Europe-wide energy tax by the year 2002.

The emphasis that many countries put on emission trading concepts is further evidence of the importance of energy and resource prices in implementing the Kyoto Protocol. This, of course, is also a possible path for a pricing policy since there may be differences in the perception of particular instruments on different sides of the Atlantic. Since direct pricing through the use of ecological taxes does not seem to be an option for United States legislators, indirect pricing by tradable quotas might do the job. Many economists fear, however, that trading resource quotas could lead to rather unpredictable price developments. Progressive taxes, on the other hand, provide for stable expectations and may allow better medium and long-term planning for industry and consumers.

Establishing an internal trading system in the United States and other countries should diffuse some rather unjustifiable fears of comparative disadvantages

Politically, establishing an internal trading system in the United States and other countries should diffuse some rather unjustifiable – but nevertheless powerful – fears of comparative disadvantages by some EU member states. Introducing an EU energy and CO_2 tax required unanimity: it failed in 1992 because these states insisted that it be made dependent on major industrialized countries outside the EU introducing it as well.

Of course, none of the perceived detrimental effects on competitiveness appeared in those European countries that unilaterally opted for a greening of taxation – partly due to the clever ways their ecological tax reforms were designed. But, anyway, these arguments completely lost their rational after Kyoto. The reduction and limitation commitments by major industrial powers have created a level playing field in this regard.

Cooperation and coordination

This diversity of instruments for implementing the Kyoto Protocol's obligations demands enhanced cooperation amo the Parties. Article 2 therefore calls upon industrialized countries to cooperate, to share their experiences and exchange information. The Parties are also asked to consid ways of facilitating such cooperation at its first session, or soon as practicable thereafter. They may, furthermore, consider how to elaborate the coordination of policies and measures. Preparations for this should start immediately within the Convention's bodies and not wait for the Protoc to come into force. Emissions trading and ecological taxes can be made mutually compatible and supportive – true no just for a global emissions trading regime that can be supported by national or regional ecological tax systems, b also for the compatibility of different pricing systems in various countries.

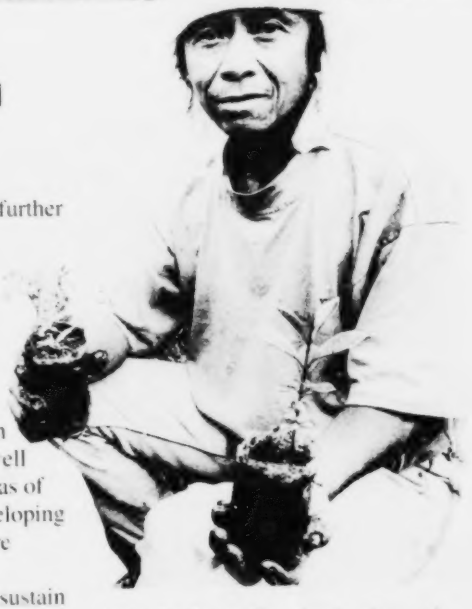
This concerted effort towards an Ecological Tax Refor will ultimately render the wasteful, unsustainable use of energy and resources obsolete, and thus contribute to the ultimate objective of the Convention on Climate Change: to prevent dangerous interference with the climate system Using the forces of the market will also contribute to the sustainable development of industrialized countries, and provide a powerful and persuasive example that developi countries can follow •

Professor Ernst Ulrich von Weizsäcker is President and Hermann E. Ott is Senior Fellow at the Wuppertal Institu for Climate, Environment and Energy, Germany.

Catch that carbon

Peter Hoare/Int MPI/Topham Picturepoint

MADHAV GADGIL examines ways of cutting emissions of carbon dioxide by growing forests and burning hydrogen



Chris Stowers/Panos Pictures

It is some 300,000 years since our ancestors first began to deplete the world's stocks of carbon. It started when they learned to control fire. For a long time they must have used dead and fallen wood, only gradually switching to chopping down trees, then to digging for coal, and now to drilling under the oceans for petroleum and natural gas. The large releases of energy from this stock of carbon have permitted our species to build up ever more elaborate social institutions and to shape the world to our own ends.

But meanwhile carbon dioxide (CO_2) has built up in the atmosphere, absorbing long wavelength radiation emitted from the Earth, and leading to global warming. We now need to 'sequester' carbon – to remove it as CO_2 from the atmosphere and set it aside, preferably as molecules of reduced carbon, i.e. hydrogen-containing molecules such as sugars, cellulose and hydrocarbons, to augment the currently rapidly depleting stock. The time has come to deploy the institutions we have built up with the help of all the energy gained from reduced carbon to promoting the further production of such carbon, to cutting the rate at which we are burning it up, and to guiding CO_2 to destinations other than the atmosphere.

Increasing the growth of plant matter is an effective way of stepping up the rate of production of reduced carbon. This is now well below its potential over large areas of the Earth, particularly in the developing countries. Many of these areas are undulating lands, unsuitable for cultivation; others are too dry to sustain agriculture. If only we could organize ourselves, every hectare of these lands could support several hundred tonnes of plant matter above and below ground, removing a great deal of CO_2 from the atmosphere in the process. The barriers to such an enhancement of productivity are not so much technological as human. For most of these lands support people who subsist by gathering living resources with their own hands, or through low-input agriculture and animal husbandry. Many have no choice but to harvest wood or graze their flocks on these lands, demands which are incompatible with dedicating them to building up plant biomass.

Enhancing biomass production only becomes possible in such areas if it also helps these people sustain their livelihoods. One way of doing this is to use the biomass as an energy source. Trees would be periodically harvested; if they were cut after 10 years' growth, 10 per cent of the area of the energy plantation could be harvested every year.

Many factors need to be taken into ▶

Habitat Action/Panos Pictures

account in working out the efficacy of carbon sequestration through energy plantations. If the relatively young trees harvested in such a plantation are only 20 per cent of the size of fully grown ones, it will only sequester 20 per cent as much carbon as a forest totally dedicated to sequestration. Furthermore the plantation would consume some energy, for instance in replenishing soil nutrients. Yet, on the other hand, its wood will provide energy that might otherwise have been generated by a thermal power plant, thus adding to the CO_2 in the atmosphere.

Exploring options

As might be expected, energy plantations are a desirable option where the land is fertile and can support high rates of growth but is currently unused. They are not particularly cost-effective where productivity is low, or where the land already supports a good forest stand. Clearing away existing forest to create such plantations is not an attractive choice for sequestering carbon, especially where the growth rate is unlikely to be high. Nor is raising energy plantations on degraded lands that are unlikely to support high rates of tree production. But such rehabilitation of degraded lands may be highly desirable as a component of rural development programmes.

Such rehabilitation could usefully be modelled on the traditional system of land use in the northeastern Indian state of Manipur on the borders of China and Myanmar. Here uncultivated lands were put into two categories: 'supply forests' and 'safety forests'. Supply forests, covering about 40 to 60 per cent of the land, were harvested for firewood or small timber in a regulated way. Safety forests, some 10 to 30 per cent of the land, were traditionally protected as sacred sites – but often continued to be safeguarded even after the loss of religious beliefs because they served as firebreaks at the time of slash-and-burn agriculture. Left untouched, they supported biological communities in a state of equilibrium and constituted a dispersed system of refugia – areas where populations of organisms can survive even if they are exterminated elsewhere – that sustained the diversity of many groups of organisms. Remnants of such safety forests survive even in thickly settled, intensively cultivated tracts of the southwestern coast of India. Here primeval stands of evergreen dipterocarp forest extending over several hectares still occur in villages such as Iringole in the Ernakulam district of Kerala. I have asked villagers and workers from non-governmental organizations whether it might not be possible to dedicate 10 per cent of the land dedicated to energy plantations on degraded lands to raising such safety forests, perhaps in patches of 0.5 to 2 hectares, stocked by indigenous plant species and left permanently untouched. Many have reacted enthusiastically. These refugia could

Safety forests supported biological communities in a state of equilibrium and constituted a dispersed system of refugia

both serve to sequester carbon to the maximum extent possible in the prevalent environmental regime and contribute towards the conservation of biological diversity.

New technologies

A second approach to sequestering carbon arises from new ways of extracting energy from reduced carbon compounds. All of these – whether in petroleum, natural gas or kitchen wastes – contain hydrogen, and it is now technically possible to isolate this and use it as a clean fuel that produces water as its only by-product. The process of isolating the hydrogen will simultaneously produce almost pure CO_2. This can be banished to underground storage such as in partially depleted petroleum reservoirs or deep coal beds. Driving CO_2 underground in this way could also perform other useful functions, by forcing otherwise inaccessible petroleum or coal-bed methane reserves to the surface. If the release of CO_2 to the atmosphere is taxed, as in Norway, such possibilities become all the more attractive.

These are then two, in some ways diametrically opposite, avenues for sequestering carbon. One is the traditional, tried and tested route of growing plants for energy production, leaving some areas untouched as refugia for biological diversity. The other is the, as yet commercially untested, possibility of using hydrogen as a fuel, while storing the concomitantly produced CO_2 in geological reservoirs. Both pose exciting challenges which were the subject of a recent brainstorming session of the Science and Technology Advisory Panel of the Global Environment Facility•

Professor Madhav Gadgil is a professor in the Centre for Ecological Sciences at the Indian Institute of Science, Bangalore, India, and Chairman of the Science and Technology Advisory Panel of the Global Environment Facility.

Jeffrey Plowright

START LOCALLY

R. K. PACHAURI says developing countries must use economic instruments to tackle local environmental problems before they can be explicitly designed for climate change

The ever-increasing threat of climate change is truly a global problem, with impacts not just in one location but elsewhere on Earth. El Niño's influence on delaying the monsoon rains in Indonesia, and thus permitting large-scale fires to rage unabated, shows that climate-related phenomena in one part of the planet can have enormous impacts in other, remote regions of the world.

Sceptics of climate change err when they believe that – even if the scientists' predictions of global warming are generally right – parts of the globe would actually benefit from it. The Earth's climate system is an extremely complex interplay of phenomena: there could not be a mere change of temperature without other impacts. Some of the regions close to the Arctic Ocean, for example, could benefit from warming, but such other effects as higher snowfall and changes in air currents and the level of the ocean might counter any benefits. Other likely effects are difficult to quantify even with the most sophisticated climate models employed by outstanding scientists.

The principle of common, but differentiated, responsibility enshrined in the United Nations Framework Convention on Climate Change should be paramount when action is taken to mitigate emissions of greenhouse gases. The Convention has to deal with a complicated set of forces representing both the narrow self-interest of individual societies and nations and the larger common interest of the whole of humanity. Much has been said – particularly in the rhetoric leading up to the Third Conference of the Parties at Kyoto – about the 'meaningful participation' of key developing countries in reducing greenhouse gas emissions, but the proponents of this approach have scarcely been able to spell out what it means. Perhaps this is because their guarded desires go against the tenets and principles of the Convention on Climate Change and all that was agreed to in the first two meetings of the Parties. Several negotiators from developed countries seem impatient and annoyed that developing-country positions appear to be permanently obstructive and non-cooperative, insisting only on the need to transfer financial resources and technology from North to South. By articulating 'meaningful participation' they may perhaps be trying to strengthen their own bargaining positions in the negotiations for implementing the Kyoto Protocol and beyond.

It is important to understand the capacity of developing countries to do what is possible and the constraints stopping them doing what is not

There is a certain myopia in this approach, because if the true intent is to bring the large developing countries on board for mitigation of greenhouse gas emissions, it is important to understand the capacity of these countries to do what is possible and the constraints stopping them doing what is not. It would be far more productive and participative to define the areas where partnerships and cooperation are possible.

Common ground

The history of action to protect the environment may help to point up where a common interest between countries of the North and the South could lie. In 1962 Rachel Carson brought out *Silent Spring*, triggering worldwide concern over the damage being caused to the health of the Earth's ecosystems through the effects of what we call human progress. Rapid industrialization, ignoring the internalization of environmental costs in the pricing and costing of goods and services, had led to unforeseen environmental problems in the developed world. It was only later that a new-found awakening led to action being taken to clean up rivers, the soil and air in Europe, North America and Japan. Initial efforts relied largely on command-and-control actions. After some time it was realized that, though these were successful in several respects, they were not cost-efficient.

Pollution and environmental damage originally increased in developed societies as income levels rose: it was only ▶

after action was taken to improve environmental quality in the 1960s that the damage decreased even though incomes continued to grow. This is best illustrated by the familiar environmental Kuznets curve. The developing countries are very much in the lower left hand corner of the curve, which will perhaps follow a similar shape for them as they establish their own trajectory in the relationship between economic output and environmental quality. The critical challenge that they face is to adopt institutional, technological and policy measures to allow them to pursue a much shallower curve, so that they can start improving the environment at a lower level of growing income. This is possible with the help of the policy experience established in developed countries – particularly in the use of market-based instruments – and the array of technologies now available and likely to become so in the near future. This is the area of common ground on which the interests of developed and developing countries can converge.

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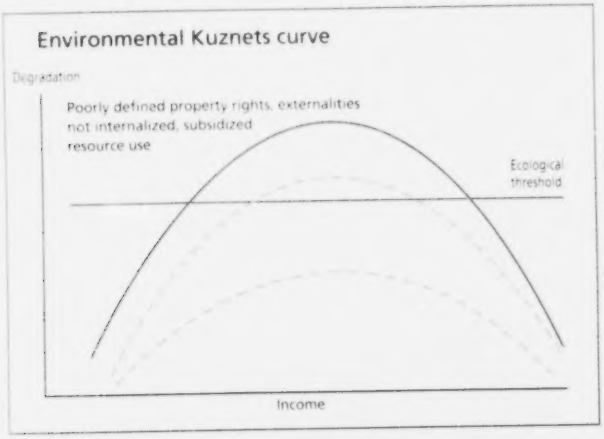
A dual approach

Two major issues need to be considered in looking at the possibility of using market-based instruments for mitigation of greenhouse gas emissions in developing countries.

First, many actions both improve the local environment and reduce greenhouse gas emissions. These include such options as improving efficiency in the entire energy cycle, switching from coal to oil and from oil to natural gas, using more renewable energy technologies, and improving transport systems both to make existing modes more efficient and to shift emphasis from private to public transportation.



Second, action to reduce greenhouse gas emissions can only be effective if institutional, regulatory measurement systems for protecting the local environment are in place. The developed countries have reached a point where market-based instruments can be used effectively, since they have the institutional arrangements and mechanisms to monitor and measure them properly. Developing countries will not be able to reduce greenhouse gases unless their institutions also reach a reasonable level of development and the entire architecture for taking effective environmental protection measures is established. They must trace out a lower environmental Kuznets curve; they will only be able to do so if pricing decisions, taxes and market incentives for pollution abatement become an integral part of economic policy.

Developing countries are still quite a distance from a regime that ensures the use of market-based instruments for reduction of greenhouse gas emissions. Developed countries must help them set in place the scientific and institutional arrangements for managing local environmental issues effectively. It is only once experience, success and full understanding have been achieved with using such arrangements for local initiatives that the reduction of greenhouse gas emissions can be explicitly considered. In view of the rationale of common but differentiated responsibility in the Convention on Climate Change, the architecture for effective local environmental protection in the developing countries must first be established both as a practical prerequisite and as an ethical imperative•

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Trading gases

RICHARD L. SANDOR says that emission trading is the cheapest and most effective way to fight climate change and outlines how a market should be set up

It is no wonder that we have managed fundamentally to alter the chemical composition of the atmosphere. For we have treated it as an unlimited resource, available to all in unlimited quantities, at no charge.

Nobody owns the atmosphere, so nobody takes account. Respectfully treating it as the limited resource it really is requires limiting its consumption, and instituting a process for treating it responsibly. The zero price now being charged for its use means there is no direct reward to those who might supply carbon abatement and sequestration services. Private capital is not being mobilized. The market is missing. It must be introduced.

Emission taxes, command-and-control regulations and other non-market policies are likely to be part of the policy mix needed to achieve the Kyoto targets, but they fail to exploit cost efficiencies and may not yield the desired emission reductions. An international, market-based, emission allowance trading regime can help solve the climate change problem while offering a dynamic flexibility that translates into cost-effectiveness. Keeping environmental protection affordable is critical to maintaining public support.

Understanding how markets evolve makes it possible to identify specific steps to establish one in greenhouse gases. There are, admittedly, few well-designed environmental markets, but the dramatic success of America's sulphur dioxide allowance market in combating acid rain, for example, strongly argues in favour of managing climate change by promptly establishing a greenhouse gas emissions trading programme.

Environmental markets did not appear spontaneously any more than did the commodity, equity, and bond ones that preceded them. Like any other good or service, they are responses to latent or overt demand. Specific legal and institutional infrastructures have to be developed if they are to evolve successfully.

A seven-stage process

History suggests that markets evolve in seven stages:

1. A structural economic change that creates the demand for capital.

2. Creation of uniform standards for a commodity or security.

3. Development of a legal instrument which provides evidence of ownership.

4. Development of informal spot markets (for immediate delivery) and forward markets (non-standardized agreements for future delivery) in commodities and securities where 'receipts' of ownership are traded.

5. Emergence of securities and commodities exchanges.

6. Creation of organized futures markets (standardized contracts for future delivery on organized exchanges) and options markets (rights but not guarantees for future delivery) in commodities and securities.

7. Proliferation of over-the-counter markets/deconstruction.

There have been many examples of this. The seven-stage process holds true, for example, for the evolution of the equity-capital market beginning with the need to finance the Age of Discovery that brought Columbus to the Americas; for the evolution of trading in agricultural commodities in America in the 19th century; and for the refinement of markets for instruments that support the housing finance system in the United States in the 20th century.

Similarly, increased pollution by sulphuric emissions accompanied increased electricity demand and output. Latent demand became effective demand as public concern over human health and environmental damage motivated legislators to pass the Clean Air Act Amendments of 1990.

These set an overall national limit on sulphur dioxide emissions, ultimately requiring a 50 per cent cut. Under a command-and-control regime, coal-fired utilities would have had little choice but to purchase expensive pollution control technologies to meet the lower targets. Instead, a market-based 'cap-and-trade' system was adopted. Utilities could either reduce emissions directly or purchase allowances from others that cut emissions below their targets. They were motivated to reduce emissions because they could sell their unused allowances. Those that did not make cuts had to buy more allowances or face stiff fines. All rules protecting local air quality remained in force.

Multiple benefits

In a single stroke, the Clean Air Act performed three functions: it standardized an environmental commodity (a legally authorized allowance to emit 1 ton of sulphur dioxide); it produced the 'evidence of ownership' necessary for financial instruments; and it established the infrastructure to transfer title efficiently. An informal forward market emerged even before the Act required compliance. Options followed. Organized exchanges arrived when the Chicago Board of Trade (CBOT) competitively won the right to conduct the annual allowance auctions on behalf of the Environmental Protection Agency (EPA); it continues to provide this service *pro bono*.

The overwhelming success of this programme, and others like it, may help to motivate the international community to accelerate the establishment of a pilot phase for greenhouse gas emissions trading. Before the United States sulphur programme was launched, most forecasters predicted that compliance costs would range from $300 to $900 per ton. The first trades were executed in 1992 at around $300 per ton; but the price at the first EPA/CBOT auction ▸

was $131 per ton. In 1998 it hovered from $115 to $160. Meanwhile, total emissions came down ahead of schedule: between 1995 and 1997, aggregate emissions were more than 33 per cent below sanctioned levels. As *The Economist* put it: 'Overall, this [programme] has cut sulphur emissions faster and more cheaply than anyone predicted.'

This major success interests both the environmental and business communities because it reflects the win-win possibility of emissions trading.

Keeping environmental protection affordable is critical to maintaining public support

Turning this possibility into a probability includes such conditions as strictly limiting and precisely measuring pollution levels, and enabling industry to comply with the law using flexible and creative instruments.

Other less well-known programmes involving resource permitting and emissions trading helped phase out lead from gasoline in the United States and have been introduced in such diverse nations as Poland, New Zealand and Chile. Internationally, the Montreal Protocol on Substances that Deplete the Ozone Layer allows the use of market-based tools, and these have contributed to its success in cutting the production of ozone-depleting substances.

Increased interest

Policy makers continue to debate alternative tools to restrict greenhouse gas emissions. Emission taxes have an unpredictable effect on the level of emissions and carbon taxes are politically unfeasible in many countries. But in just a few short years, the idea of using tradable permits to combat global warming – which I first articulated in preparation for the 1992 Rio Earth Summit – is gaining widespread acceptance.

As the Kyoto agreement is implemented, a wealth of lessons is available from the seven-stage process and from other examples of inventive activity ranging from aircraft to computers. The evolutionary development pattern of many international agreements, such as the World Trade Organization and the European Community, is also pertinent: most of the expansive, large-scale, multilateral institutions started as targeted, small-scale, plurilateral protocols.

History suggests that the best approach to realizing a large-scale greenhouse gas trading system would be to begin with an early, no-frills, limited-scale, voluntary carbon dioxide pilot programme. Participating national governments would agree to enforce a system where their domestic emission sources can reach emission limits jointly by trading with emission sources in other participating countries. Non-member governments could choose a more limited 'opt-in' by agreeing to monitor emissions and certify emission reductions for industries or individual firms that voluntarily choose to participate in the initial phase. Provisions must be made for new members, and to address unregulated gases and uncovered emission sources and sinks. In this way, the market would be flexible and resilient enough to assure its structured evolution.

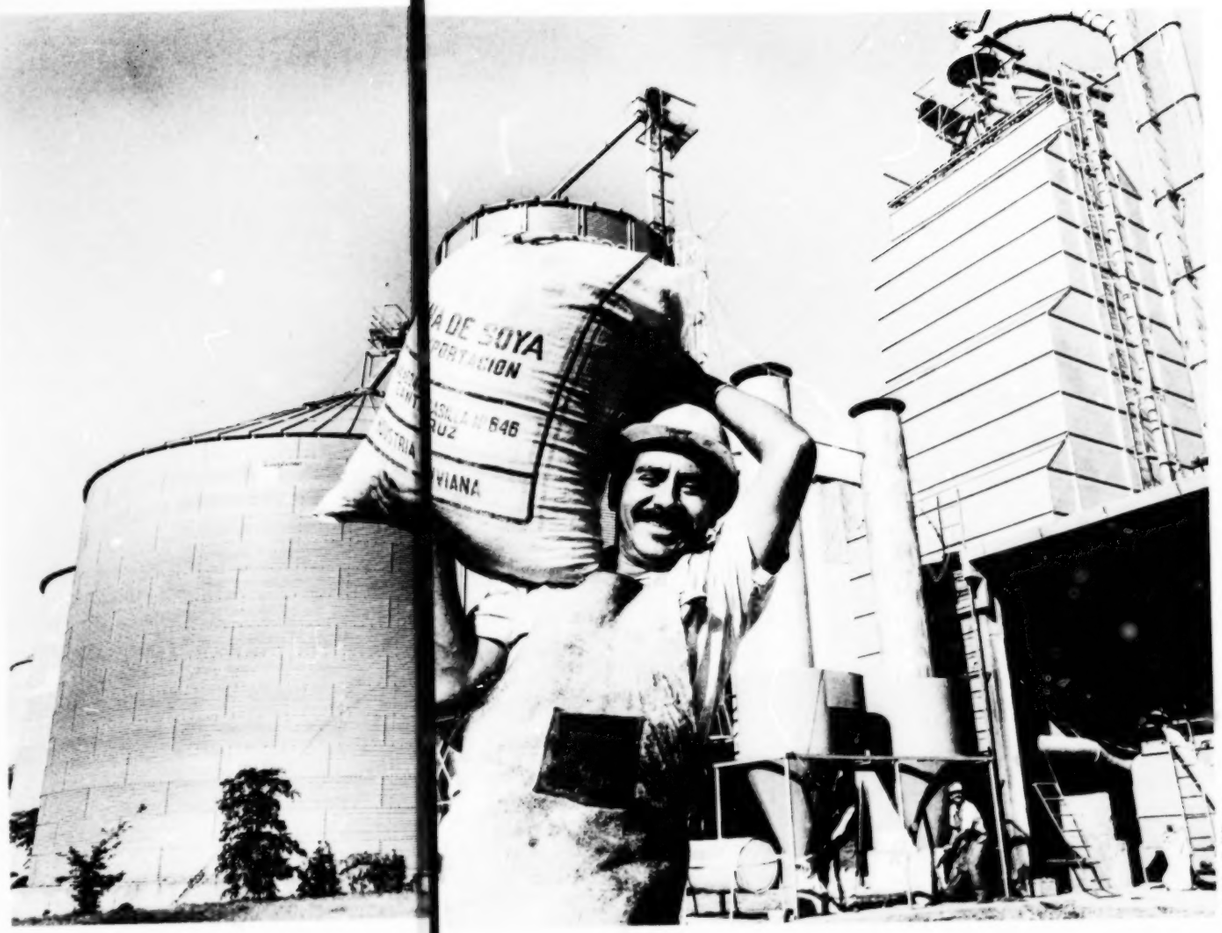
A limited-scale greenhouse gas trading programme is an essential step on the path to a larger international system. Pioneers will be needed to face the challenge of innovation, and it is in the interest of the major emission sources to assume this role. Some companies (such as Suncor in Canada and Niagara Mohawk in the United States) and countries (like Costa Rica) have taken up the mantle of leadership in the nascent market.

The inclusion of the Clean Development Mechanism in the Kyoto Protocol was extremely encouraging. If properly designed, it can help realize the remarkable capability of tradable emission permits to deliver a 'double dividend' – helping to lower the cost to the public of addressing climate change and acting as a powerful mechanism for transferring clean energy technologies and financial resources from industrialized to developing countries.

Impressive economic benefits flow from driving down the cost of cutting greenhouse gas emissions. The industrialized world can take very meaningful steps to bring down emissions at a cost of about one tenth of 1 per cent of GDP, if market-based methods are used. Many of the early transactions have occurred at prices that would imply even lower overall costs, and my firm has directly observed very large reductions in emissions being offered at similar levels.

Defining goods

The first step in developing the missing greenhouse gas market is to define the commodity. Kyoto provided a cap on total emissions and delineated the basis for creating the property right, or commodity. Other key ingredients now needed include participants' baseline emission rates, initial allowance allocations, and protocols for monitoring emissions and calculating the benefits of emission avoidance or sequestration programmes.



Drawing on the lessons from the introduction and evolution of new markets, there are 12 steps to implementation. They could be called the 'clean dozen':

- Clearly define the tradable commodity for greenhouse gas emissions.
- Establish a market oversight body.
- Establish emission baselines.
- Clearly specify allocation and monitoring procedures.
- Establish uniform, non-segmented allowances.
- Launch an international allowance clearing-house and registrar.
- Employ existing exchange and trading systems.
- Use allowance auctions to assist the market.
- Develop standardized trade documentation.
- Require cooperation among trade forums, including provisions for information sharing and mutual offset.
- Use existing expertise to design book-keeping and accounting systems.
- Provide assistance to market forums in emerging economies.

Emissions trading is an environmental and economic winner. The seven-stage process enables us to describe a common dialectic of how markets evolve. My colleagues and I – and myriad other advocates of market-based environmentalism – have been building a market architecture for a greenhouse allowance trading pilot programme and are working diligently for its practical implementation. Such a regime can target emission levels directly (which carbon taxes cannot do) and it is likely to be the most cost-effective option. So it must be near the top of the menu of

An international greenhouse gas emissions trading programme has already moved from a possibility to a probability

policy options needed to prevent the costly threat of climate change. In the words of *The Economist*: 'There is reason to think that global emissions trading might work. And if, in the end, it does not? Little harm would have been done. The risks are negligible, and the potential economic benefits very large.'

Making moves

We must act now to take the vital first step to implement a voluntary trade regime with binding emission limits. This needs to provide sufficiently flexible incentives so that the private sector taps into an unparalleled wealth of specialized knowledge and entrepreneurial creativity. Stated positively, we must 'learn by doing'. Stated negatively, we must not follow the fallacious rhetoric of the *status quo* that offers a map down a road with no outlet: 'Do not initiate a programme until you learn all the drawbacks. And you cannot learn about the drawbacks until you initiate the programme.'

Innovative private entities and non-governmental organizations – and leading governments – possess unique sets of knowledge and skills. Only when these are brought to bear individually and collectively on the problem of climate change will the risk be appropriately managed.

An international greenhouse gas emissions trading programme has already moved from a possibility to a probability. The time has come for the public and private leaders of the world community to make it a reality •

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Time to adapt

St Hoe Kratz / M P Topham Picturepoint

JAN F. FEENSTRA calls for urgent policy changes to give a higher priority to adaptation to climate change in developing countries

Developing countries urgently need to draw up programmes describing how they are going to adapt to climate change. But at present the emphasis of their country studies reports and national communications is on making inventories of their emissions of greenhouse gases and on working out how to reduce them.

This is understandable in view of the ultimate objective of the United Nations Framework Convention on Climate Change: 'to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.'

Yet developing countries make only a small contribution to humanity's total worldwide greenhouse gas emissions, and most of them are particularly vulnerable to climate change. Also, the effects are likely to be most severe in these countries, and they lack the financial resources to cope with them.

The Intergovernmental Panel on Climate Change (IPCC) concluded in its Second Assessment Report that 'the balance of evidence suggests that there is a discernible human influence on the climate'. And it is no secret that the emission reductions agreed at Kyoto are by no means enough to counteract climate change in the coming decades. So there urgently needs to be more emphasis on the impact of climate change, and on studies on adapting to it in developing countries. This is underscored in a clause in the Kyoto Protocol on the Clean Development Mechanism which states: 'The Conference of the Parties shall ensure that a share of the proceeds is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.'

This implies that developing countries know (or will in the near future) what the adverse effects of climate change will be and have identified adaptation measures to cope with them. Quite a number of developing countries have conducted climate change impact and adaptation studies (mainly through bilateral country study programmes), but the results show that more in-depth research is required before sound, well worked-out and cost-effective adaptation measures can be proposed in developing countries.

Insufficient resources

Adaptation has mainly been studied in conjunction with the impacts of climate change. Experience from several countries shows that the major effort goes into the impact studies and that projects run out of time and resources by the time they are ready to assess adaptation options: in most cases there is not enough time and funding even to study the effects of climate change on all sectors of the economy. It is also

difficult to link the uncertain impacts of uncertain climate – and socio-economic scenarios – to concrete adaptation measures. These kinds of studies are new to most scientists in developing countries and so they need the guidance of reliable literature to inform them of possibilities as well as any available international published material and technical assistance. Impact and adaptation studies also require a multidisciplinary approach and strong coordination to ensure consistency in scenarios, assumptions and data used and to enable scientists with different disciplinary backgrounds to communicate adequately.

An overview of the results of impact and adaptation studies conducted by scientists from developing countries can be found in the forthcoming *Proceedings of the International Conference on National Assessments Results of Climate Change: Impact and Responses*, San José, Costa Rica, March 1998.

Urgent start

The urgency and importance of adaptation to climate change in developing countries makes it better to start studying it without waiting until the problems have been solved, even partially. Adaptation studies do not need to be directly linked to in-depth impact assessments.

These adaptation studies can be conducted in at least two ways.

First, they can study how vulnerable and important sectors in a country are coping with present climate variability, and how its adverse effects, now or in the past, could have been avoided or decreased. Assuming that in future, extreme weather events (floods, droughts, heat waves, coastal storm surges etc.) will increase in a changing climate, much can be learned from today's problems and past experiences.

Second, they can carry out specific in-country research into the four generic categories of anticipatory adaptation presented in the report of the Science and Technology Panel of the Global Environment Facility (GEF), *Planning for Adaptation to Climate Change*:

- Increasing the robustness of infrastructural design and long-term investments (e.g. by extending the range of temperature, precipitation or sea-level rise that a system can withstand without failure).

- Increasing the flexibility of vulnerable managed systems (e.g. by allowing mid-term adjustments or reducing economic lifetimes).

- Enhancing the adaptability of vulnerable natural systems (e.g. by reducing other stresses or removing barriers to migration, including creating eco-corridors).

- Reversing trends that increase vulnerability (e.g. by introducing measures that set development back in vulnerable areas such as flood plains, coastal zones etc.).

UNEP took the initiative in developing a *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies* to help developing countries set up and conduct studies as part of its participation in the development

of Guidelines and Handbooks for Climate Change Country Studies. A first draft was published in 1996, presenting an array of methods for impact and adaptation assessment for several sectors (such as water, coasts and agriculture). It elaborates the *Technical Guidelines for Assessing Climate Change Impacts and Adaptation* of the Intergovernmental Panel on Climate Change (IPCC) and made use of the United States *Guidance Document on Vulnerability and Adaptation*.

The *Handbook* has been tested over the last few years in several studies in developing countries. UNEP has carried out a follow-up project, with funding from the Governments of Denmark and The Netherlands, to improve it on the basis of experience in developing countries, new scientific literature and expert reviews before publication in October 1998. It will organize a full governmental and scientific review of the new version, which will then be presented to the IPCC and the Conference of the Parties to the Convention.

It is in the interest of developing countries to put more emphasis on adaptation studies

It is in the interest of developing countries – especially those with relatively low emissions and those that are particularly vulnerable – to put more emphasis on adaptation studies. This requires a shift in the funding criteria and mechanisms of climate change country studies financed by the GEF, which should also invest more in planning for adaptation.

As the San José Conference in March 1998 concluded: 'There has to be a concerted effort to develop and enhance the capacity of developing countries to conduct assessment of climate change impacts and adaptation' •

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FIRE watch

JOHANN G. GOLDAMMER describes how global warming and forest wildfire disasters may become locked in a vicious circle

Many types of forest, historically adapted to outbreaks of fire from both natural and human sources, are now becoming increasingly vulnerable to it. This is the result of changes in demography and land use, and the cumulative effects of the disturbances brought about by humanity.

Fire is an important recurrent natural phenomenon in all vegetation zones, ranging from the tropics to the northern circumpolar conifer forests. In some ecosystems it maintains the dynamic equilibrium responsible for high biodiversity and economic productivity. In others, such as lowland and mountain rain forests, it destroys the forest cover and leads to long-term site degradation. But, in most areas of the world, wildfires burning under extreme weather conditions have severely damaged economies and human health and safety and caused major disasters.

Extended wildfires in the Indonesian and Malaysian provinces on the island of Borneo during the drought of 1982-1983 – caused by the El Niño-Southern Oscillation (ENSO) – burned more that 5 million hectares of forest and agricultural land, at a total cost of around $9 billion. The effects of similar fire episodes in 1997-1998 in Indonesia, Brazil and Central America have not yet been fully assessed but preliminary estimates suggest that the total value of damage to health, industrial production, tourism, agriculture, timber and other forest products, biodiversity, and air, ground and sea transport – together with the cost of fire-fighting – exceeds $5 billion.

Australia's Ash Wednesday Fires of 1983 – also linked to the extreme ENSO drought of 1982-1983 – killed 75 people and nearly 300,000 sheep and cattle, and destroyed 2,539 houses. In 1987 wildfires in the People's Republic of China killed 221 people (mainly as a result of high carbon monoxide concentrations in forest villages), made 50,000 homeless and burned 1.3 million hectares of mountain forest. Indeed between 1950 and 1990 a total of 4,137 people were killed in forest fires in China. The last major fires in central Eurasia were in Mongolia, where 10.7 million hectares of forest and steppe vegetation were burned in 1996, followed by a further 12.4 million hectares in 1997.

Health hazards

Smoke pollution from burning vegetation sometimes causes death and illness. The most serious pollution problems in the 1980s and 1990s have been in the Amazon Basin and in Southeast Asia. The most recent large smog episodes in Southeast Asia were in 1991, 1994 and 1997 when land-use fires and uncontrolled wildfires in Indonesia and neighbouring countries created a layer of smog which covered a wide region for several weeks. A study on asthma attacks in children showed that high concentrations of carbon monoxide, nitrogen dioxide and inhalable suspended particulate matter, all generated by the fires, were to blame – the smog of September 1997 caused the worst smoke pollution ever recorded in the region.

Wildfires in vegetation contaminated with radioactivity cause uncontrollable releases of such radionuclides as caesium 137C, strontium 90 and plutonium 239. This happened, for instance, in the severely contaminated region near the Chernobyl nuclear power plant.

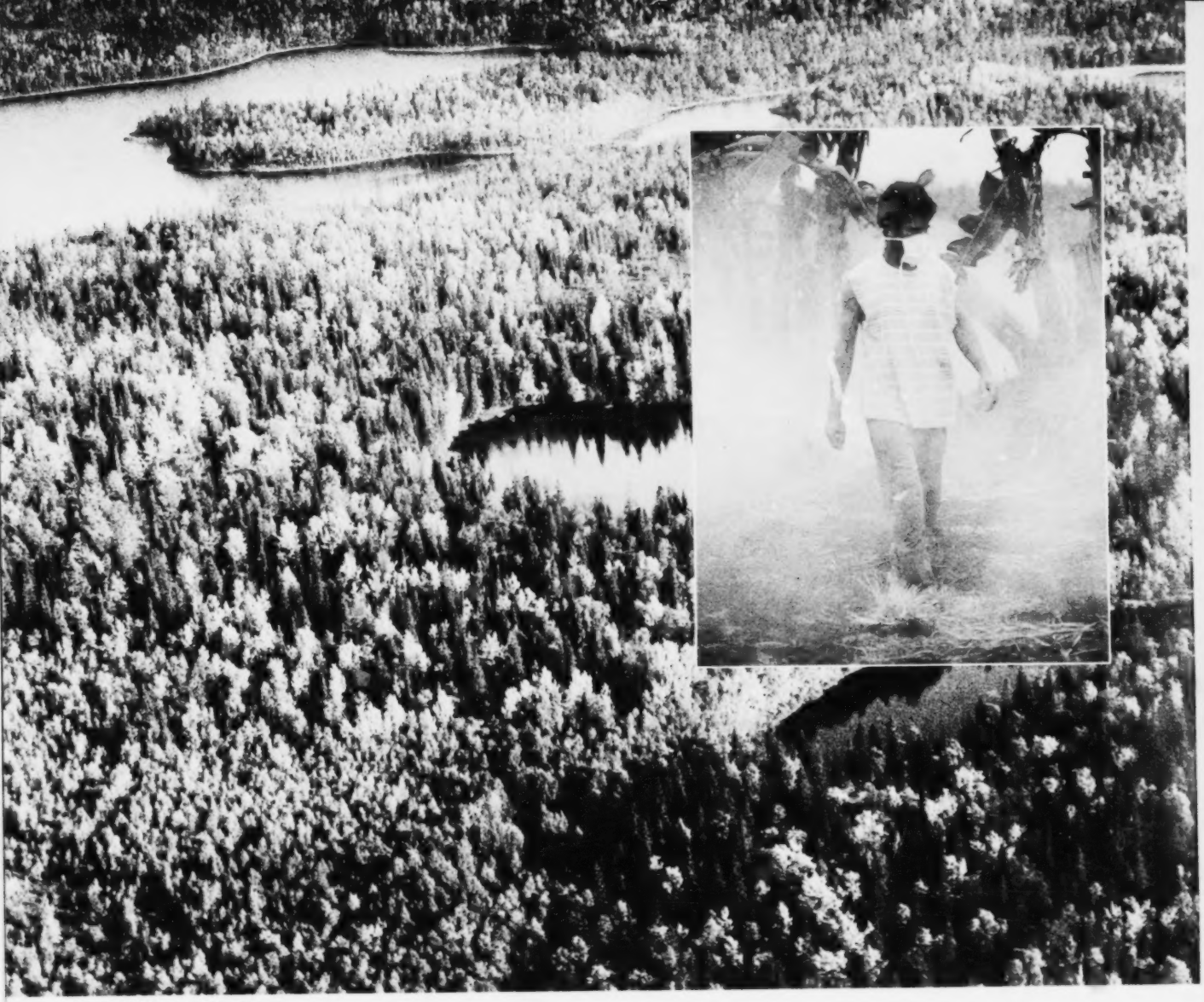
Vegetation fires also produce emissions that affect the composition and functioning of the global atmosphere – and interact with those from burning fossil fuels and other technological sources which are the major cause of human-induced climate change. Recent estimates suggest that some 2 to 5 billion tonnes of carbon stored in vegetation may be released annually by fires and other burning of plant biomass including biofuels. Most of this, however, is sequestered by regrowth of vegetation.

Net emissions

The net emission of carbon into the atmosphere from deforestation has been estimated to be in the range of 1 to 1.5 billion tonnes per year. Savannah fires, land-use changes, shifting agriculture, agricultural waste burning and fuelwood consumption all make important contributions to the total worldwide burning of biomass, and are included in these figures.

Emissions from tropical vegetation fires are dominated by carbon dioxide (CO_2), but products of incomplete combustion that play important roles in atmospheric chemistry and climate are also emitted: these include nitrogen oxide, carbon monoxide, methane and reactive hydrocarbons, which influence the concentrations of ozone and hydroxyl radicals and thus the oxidation efficiency of the atmosphere. These particularly affect tropical regions during the dry seasons – August to November in the southern hemisphere and January to May in the northern one; they are manifested in strongly enhanced tropospheric ozone concentrations, which extend throughout regions regularly affected by forest conversion and dry forest burning in Brazil, by savannah fires in southern Africa, and by land-use fires in Southeast Asia. Concentrations of methyl chloride and methyl bromide – which, with methane, play a significant role in stratospheric ozone chemistry – are also strongly dominated by vegetation fires.

The most critical fires occur during extreme droughts, and the El Niño-induced climate variability is usually closely connected with increased fire activity and damage. Droughts are expected to be more frequent in a world where the atmosphere contains twice as much CO_2 as it did at the beginning of the industrial revolution, and which – the Canadian Climate Centre's Global Circulation Model predicts – will be 3.5°C warmer. The fire season will grow longer, leading to more large, high-intensity wildfires. Canadian scientists predict the season will increase by an average of



V. Silnov/UNEP/Topham Picturepoint

some 30 days a year, with the area of their country's boreal forests that burns each year increasing by a fifth. Increased fire activity will also be particularly critical for the larch forests of eastern Siberia, where it is expected to cause large-scale losses.

Feedback loop

Drought and fire may also release carbon from the peat bogs and swamps of the boreal zone. Between 66 and 98 billion tonnes of carbon are estimated to be stored in living and dead plant biomass in the global boreal forest area. Thus more fires, arising from more frequent and intense drought, may produce an additional pulse of CO_2 to the atmosphere, acting as a feedback loop in global warming. Global climate models also predict more frequent and more intense El Niño events in a warmer world, causing drought, fire and socio-economic problems in many parts of the planet.

In the past, forests have been an important buffer against climate change because of the way they absorb carbon. But warming, bringing more frequent drought and fires, may affect the balance of the global carbon pool and release extra CO_2 into the atmosphere.

Urgent action is required at all levels of politics and policy, strategy development and management, with action plans being based on fundamental research. Fire management strategies – including preparedness and early warning – cannot be generalized because fire has such multidirectional and multidimensional effects in the different vegetation zones and ecosystems and because many different cultural, social and economic factors are involved. So UNEP faces a challenging task in coordinating the United Nations response to fire, and depends on contributions from such interdisciplinary science programmes as the International Geosphere-Biosphere Programme, and from other United Nations efforts, like the International Decade of Natural Disaster Reduction and the International Tropical Timber Organization, the World Meteorological Organization's Global Atmospheric Watch Programme and the World Health Organization's Guidelines Project on Health and Forest Fire Events•

Dr. Johann Georg Goldammer leads the Fire Ecology Research Group at the Max Planck Institute for Chemistry, Germany.

Peter Turnley/Panos Pictures

SIBLING RIVALRY

PETER USHER warns that La Niña may be succeeding El Niño, and calls for research to understand and anticipate both phenomena

'If Winter comes, can Spring be far behind?'

If Shelley had been familiar with present-day climatology, he might well have replaced the seasons with El Niño and La Niña. Over 1997-1998 global climate was largely controlled by what is generally accepted as the largest El Niño of all time, and local weather suffered extreme anomalies. Conditions are now favourable for its sister – the less familiar, but equally threatening, La Niña. This could unsettle the world's climate for another year, provoking equally devastating – if often different – weather.

So what are these capricious siblings? El Niño is an anomalous warming of the central and eastern equatorial Pacific Ocean. A natural pool of warm surface water covering thousands of square kilometres of the western Pacific is normally held in place by seasonal easterly trade winds and a favourable horizontal air-pressure structure. But occasionally (approximately every three to four years) it moves eastwards as the wind and pressure patterns are reversed, and accumulates near the coasts of Central and South America. But it is more than an ocean temperature anomaly. It manifests major interactions between the oceans and the atmosphere which extend beyond the equatorial Pacific. For example, the west Indian Ocean was warmer in 1997 than at any time in the last 100 years, contributing to the torrential rainfall that brought flood, death and economic disaster to eastern Africa.

The phenomenon was first recognized off the coast of Peru when warm water replaced the normally nutrient-rich colder upwellings, and so provoked the departure of the economically important anchovy and sardine – and of the fish-eating seabirds whose abundant droppings fed the guano fertilizer industry. This happened at Christmas time and so the phenomenon was called El Niño, the Spanish for 'Christ child'.

La Niña, 'the little girl', is the other side of the coin. The re-establishment of the Pacific trade winds cools the warm water to seasonal norms or, sometimes, makes it abnormally cold. The ocean thermocline moves up, raising cold water to the surface layers. Surface heat is lost to the atmosphere, possibly contributing, in a small way, to global warming.

Breaking records

1997 witnessed unprecedented warming in the equatorial Pacific. Then in May 1998, sea surface temperatures fell 8 C in 30 days, a rate beyond all past records. (In 1988, during the most significant La Niña to date, it took two months for the ocean to cool 4 C). By July, the easterly trade winds had become well established and a tongue of cold water, 2 C below normal, was developing in the central Pacific. This is indicative of an imminent La Niña, although forecasters could not confirm with absolute certainty that the rapidly cooling water would continue to get cold enough for a very strong La Niña event. (Forecasting the magnitude of an event is far more difficult than forecasting that it will occur.) Ocean/atmosphere modellers have limited experience with La Niña: there have only been two cold events since 1970 – in 1973-1975 and 1988-1989 – whereas the better-researched El Niño has occurred seven times in the same period.

El Niño and La Niña events appeared roughly equally until the 1970s and it is suggested that anthropogenic global warming may be bringing more frequent occurrences of El Niño. Examination of coral formation and similar sources confirms that both phenomena have been regular components of the historical climate record. (Some scientists consider only two climatic states: El Niño and non-El Niño, but the majority of researchers accept La Niña as a significant departure from normal, although its associated weather anomalies have a greater similarity to normal climatology than El Niño's.) Although both originate in the Pacific, neither they nor their impact remain entirely local. Their effect on the global atmosphere is so strong that high altitude jet streams are shifted from familiar patterns, and seasonably familiar pressure patterns and associated wind circulations migrate to different locations, changing regional weather.

These mechanisms are described as teleconnections. The results, though often differing from event to event in some regions, frequently have enough common features to allow long-term seasonal forecasting of the anomalous weather, permitting strategies to be developed and applied to mitigate them.

The recent El Niño predictably brought extensive drought to Southeast Asia and provided the conditions for the uncontrollable forest fires in Indonesia. It reduced the propensity for hurricanes to menace the Caribbean and the southeastern United States. Conversely, it encouraged winter storms along the California coast and an unusually warm winter in south-central Canada. It is also blamed for unprecedented rainfall in eastern Africa, although it was record high sea-surface temperatures in the western Indian Ocean that provided the direct influence rather than the state of the Pacific Ocean temperature profile.

The effects of La Niña are mostly opposite to those of its sibling and are generally most dramatic during the northern hemisphere winter. Previous occurrences of La Niña have brought torrential rain to Southeast Asia – welcome news for those combating

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the widespread forest fires of 1998. La Niña has been associated with an active Indian monsoon and it is usually wet in southeastern Africa during the southern hemisphere winter. This year, the monsoon has certainly lived up to expectations, but no unusual rainfall has occurred in southeastern Africa and it is likely that the still abnormally warm Indian Ocean is exhibiting a greater influence. Indeed, one of the more intriguing features of the developing La Niña is how the still lingering remnants of El Niño (as well as other dynamical influences, including those in extra-tropical regions) modify or even mask its likely teleconnections.

Diverse effects

Drought in Australia, induced by El Niño, should give way to above-average rainfall, related to La Niña, aiding grain harvests. In Canada, by contrast, La Niña's expected dry summers and bitterly cold winters (cutting temperatures on the prairies to between -30 and -40 C) should respectively reduce grain yields and increase power consumption for heating. While 1997-1998 saw few Atlantic hurricanes, La Niña is likely to spawn a significant number, some of which will make expensive landfalls on the southeast United States and some Caribbean islands. In Brazil, farmers will brace themselves for late frosts, hitting coffee and citrus production. Past experience with La Niña events makes these weather anomalies probable, but not certain. Climate is not stationary, and varies so much between years and decades that occurrences of La Niña and El Niño do not precisely replicate previous ones. There is also the uncertain influence of climate change.

Global warming has probably contributed to reducing the numbers of occurrences of La Niña compared with those of El Niño. Statistical analysis also indicates that the bigger El Niño events of the past 20 years have coincided with recorded global warming, but how much of the El Niño can be attributed to it cannot be determined at present. Nor is it clear whether the tendency for fewer occurrences of La Niña will continue as climate changes, or whether large El Niño events will become more frequent.

What is certain is that there will be future anomalous ocean temperature events in the Pacific and other ocean basins and that the world's weather will respond in unusual, if hopefully predictable, ways. But there are, however, considerable uncertainties about the cause, periodicity and magnitude of El Niño and, particularly, La Niña events and of the seasonal weather anomalies that can be attributed to them.

The weather events of 1997-1998 – and what we have yet to suffer in 1999 as La Niña bites – demonstrate the urgency of devoting time and energy to better understanding these phenomena and to using the information to make social and economic decisions that anticipate future events. For when the issues are understood and the effects can be anticipated with certainty, we may be able to view occurrences of El Niño and La Niña as opportunities rather than – as now – with dread •

Roland Seitre/Still Pictures

Peter Usher has recently retired as Chief of UNEP's Atmosphere Unit.

C. Vit/Associated Press/Typhoon Picturepoint

GATHERING FORCE

G. O. P. OBASI

In November 1998, two countries of South America will play host to two very important meetings that bear on the intimate relationship between humanity and the environment. In Buenos Aires, Argentina, the Parties to the United Nations Framework Convention on Climate Change – the Convention to mitigate and redress human impacts on the climate system – will convene for their fourth session. At the same time, in Guayaquil, Ecuador, the United Nations system will begin an assessment of the widespread and devastating impact that the global climate system can exert on humanity during the course of a single intense El Niño event.

The process to address the potential impact of human activities on climate, that began in earnest in Rio de Janeiro with the establishment of Agenda 21, was carried forward to Japan last year with the historic signing of the Kyoto Protocol. The Protocol, important though it is, was seen as only the first step in an extremely complex sequence of actions required to undo the damage already done and to set in place the basis for sustainable development throughout all the nations of the world. The Buenos Aires Conference will have to deal with the issue of 'sinks' for greenhouse gases, which has the potential for drastically changing the net emissions of individual countries and hence changing the profile of where the burden of responsibility will lie. Further, a range of new concepts, such as 'emissions trading', needs to be elaborated by the Parties. Of great interest to the scientific community is the long-term future of observing and monitoring systems that need to be assured if we are to fully comprehend the ongoing changes that may be taking place within the climate system at global, regional and national levels.

URGENCY

As if to highlight the urgency to act, the 12 months since Kyoto have seen the mean surface temperature of the Earth continue its inexorable rise of the past decade. In addition, many parts of the world have been subjected to a seemingly unending barrage of climatic extremes in the form of drought, flood and intense storms. All too often these climatic abnormalities have turned into human catastrophes.

The El Niño event of 1997-1998 was possibly the strongest event of its kind in recorded history, and disrupted the lives of millions of people across all continents. However, not all the climate extremes and severe weather events of the past year can be directly attributed to the El Niño event. Further, not all of its impacts were negative and in several instances those countries and regions that were, in the light of previous events, expected to suffer were not so seriously affected. The intergovernmental forum of experts in Guayaquil will assess the scope of the impacts of the 1997-1998 El Niño. It will assess how well the onset of the event and its course were predicted, and how well these predictions and other monitoring activities helped nations all over the world and international agencies to mitigate damage and to prepare relief measures. The forum will draw together the experiences of different regions throughout the world in coping with the event. For example, will the preparatory actions taken in several countries of South America in advance of the 1997-1998 event be applicable to countries in Southeast Asia and Africa when the next El Niño event comes, as it surely will?

EQUILIBRIUM

The World Meteorological Organization (WMO) provides the intergovernmental scientific and technical coordinating framework to improve our understanding of the climate system, to monitor its vagaries and to detect any changes that may be going on. The WMO has been especially active through its member countries and its Secretariat in providing support to these two important and complementary assessment activities. In collaboration with partner organizations within the United Nations system and other non-governmental organizations, the WMO will continue to play a vital role in the continuing struggle by humanity to move into balance with the environment of planet Earth•

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